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HOOKING MORTALITY OF WORM-CAUGHT HATCHERY BROWN TROUT[1]

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ABSTRACT

The mortality of sub-legal (in New York) brown trout taken by angling with worm-baited hooks of five different sizes was investigated, using age 1+ hatchery-reared fish released in late spring in a small pond. Comparable numbers were handled with wet or dry hands, and the hooks were removed manually, except that for some that had been deeply hooked the leaders were clipped. The fish were then held in aquaria together with control fish for 14 days and their mortality was recorded. The data were analyzed according to whether the fish had been lightly hooked or deeply hooked. Two-thirds of the trout taken were lightly hooked, and their mortality (0.9 per cent) was not significantly different from that of the controls. For deeply hooked trout, the mortality was 59 per cent when the hooks were removed but only 18 per cent when the leaders were clipped. The data suggest that, for all the trout taken, the short-term mortality would have been about 22 per cent if all hooks had been removed by hand but only about 7 per cent if the leaders had been clipped on all deeply hooked fish. Handling with wet or dry hands had little effect on mortality. The leader-clipped specimens that survived the initial test period were held over the summer and, while additional mortality occurred, all fish surviving the summer were able to feed and grow.

Hooking mortality of sub-legal game fish is an unavoidable byproduct of the use of size limits to regulate sport-fishery harvests. Minimum-size limits are generally used to increase sustained yield, either by enlarging the potential spawning population or by allowing anticipated growth to compensate for losses due to natural and fishing mortality (Everhart et al., 1975). It is assumed that long-term benefits accruing to a fishery resource protected by such limits justify the loss of undersized fish. Concern for hooking mortality may be warranted, however, if a substantial proportion of the sub-legal population vulnerable to angling is composed of relatively expensive, hatchery-reared trout.

Extensive revisions in the regulations governing freshwater angling in New York State became effective on October 1, 1977. A major change was the adoption of a 9-inch (233-millimeter) minimum-size limit on brown trout (*Salmo trutta*), rainbow trout (*Salmo gairdneri*) and splake (*Salvelinus fontinalis* X *S. namaycush*) in most waters. Formerly, there was

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project F-9-R.

no statewide size limit on these fish, and this was continued for the brook trout (*Salvelinus fontinalis*).

Of the salmonids, the brown trout is raised in the greatest numbers in State hatcheries for distribution in New York. Nearly 2.5 million were stocked between April 1, 1976 and March 31, 1977, while 0.7 million rainbow trout were released during the same period. Brown trout are generally stocked as spring yearlings (age 1+) which average 180-210 millimeters (7.1-8.3 inches) in total length. Length at time of stocking is influenced by factors such as the strain of fish used and rearing conditions at the various hatcheries. Under the new regulations, up to 90 per cent of the stocked brown trout would not be large enough to be taken legally during the period of intense angling pressure that occurs in April and May. However, a substantial number would be hooked and then returned to the water. The present study was undertaken to assess the degree of mortality among such fish. Objectives included determining the effect of hook size and relation to hooking location, as well as the incidence of sub-lethal hooking injuries and methods of reducing hooking mortality.

MATERIALS AND METHODS

The initial phase of the study was conducted at the former Fish Laboratory of the Department at DeBruce (N.Y.) from May 17 to July 13 in 1977. Brown trout of a domestic strain being reared at the Catskill Fish Hatchery were stocked in a small, man-made, flow-through pond and subsequently taken by angling under conditions that simulated the capture of such fish from small natural ponds or slow-moving streams. The pond had a surface area of 350 square meters and ranged in depth from 0.3 to 1.5 meters. Previous studies (Shetter and Allison, 1955; Mason and Hunt, 1967) indicated that hooking mortality may be highest when natural baits are used. For this reason, all angling was done with worms as bait, and single-pointed hooks were used.

A total of 1,500 spring yearlings (age 1+) 135 to 228 millimeters (5.3-8.9 inches) in total length were stocked on May 2, and 500 more were released on June 1. One or two anglers fished on 10 days between May 17 and June 7, and total fishing effort as well as water temperatures in the pond were recorded daily. Feeding was terminated at least 36 hours before fishing began. Hooks of five sizes (nos. 2, 4, 6, 8 and 10) were tested, and on a given day a sample of 50 fish was taken using the same size. Such a sample was taken for each size of hook, and then a second set of samples was taken. However, only 40 fish were caught in the first sample for No. 2 hooks. Thus data were obtained for a total of 490 trout.

Hooked fish were removed from the pond immediately and carried by grasping the leader to a central processing location, which was no more than 50 meters from any point on the perimeter of the pond. There they were placed in tubs containing 16 liters of a 1:800 solution of chloretone (25 grams of 1,1,1-trichloro-2-methyl-2-propanol added to enough

ethanol to make 100 milliliters) which lightly anesthetized them to compensate for the extended handling time during processing. After 15-20 seconds, they were removed from the anesthetic and measured, and the depth of hooking was assessed. Fish hooked in the jaws, tongue or roof of the mouth were considered lightly hooked, whereas those hooked in the eye, gills or esophagus/stomach were considered deeply hooked. For all lightly hooked trout the hooks were removed by using the fingers only, and alternate specimens were handled with wet or dry hands. For deeply hooked trout the hooks, in alternate specimens, were removed manually or left in the fish by clipping the leader, and all were handled with wet hands. Partial fin clips were used on all fish to indicate hooking location, handling with wet or dry hands and whether the hook was removed or not.

When processing was completed, the fish were put in a second tub for about 30 minutes to recover from the anesthesia. After recovery, lots of six to 16 fish were taken to the laboratory and placed in 1,325-liter (350-gallon) aquaria supplied with inflowing springwater (8° ± 1° C.). At the conclusion of each day's angling, 50 unhooked control fish were seined from the pond. These were measured, fin clipped and placed in the aquaria with trout taken by angling during the same day.

SHORT-TERM EFFECTS

All the fish taken were kept for 14 days but were not fed. Each day those that died were removed, recorded and frozen, and were subsequently taken to the Department's Fish Pathology Laboratory at Rome (N.Y.) where they were examined for pathogenic organisms. Survivors were examined for injuries in the mouth or gills after the 14-day post-hooking period.

LONG-TERM EFFECTS

All the surviving leader-clipped trout were to be held throughout the summer to evaluate the effects of hook retention on growth and survival. Of the 29 survivors from the first set of samples, 16 in which a portion of the leader or hook was visible inside the mouth were put in a separate aquarium. Since no hook or leader material was visible in the other 13, it was assumed that they had shed their hooks and they were excluded from the long-term phase of the study. However, this assumption proved erroneous; three of the 13 were dissected and all were found to contain hooks in their digestive tracts. Therefore, all 37 survivors from the second set of samples were included in the long-term study and placed in the same aquarium with those from the first set. They were assumed to still contain hooks, even if none was visible. During this part of the study the trout were fed dry pellets.

Closing of the fish-holding facilities at DeBruce necessitated removal of all fish, and on July 13 the remaining leader-clipped survivors were

weighed, measured and transported to the State fish hatchery at Van Hornesville where they were placed in a circular display pond 4 meters in diameter. About 70 brook trout, rainbow trout and brown trout ranging up to 3 kilograms in weight were present in the pond. All the brown trout were larger than those transferred from DeBruce which ranged from 145 to 236 millimeters long. All fish in the display pond were fed once a day. Experimental fish that died were removed and frozen, but dates of mortality were not recorded. The pond was seined on October 20, and all the leader-clipped fish were weighed, measured and dissected.

RESULTS

The data for the two phases of the experiment are presented separately.

Short-term Effects

Fishing effort ranged from 7 to 12 hours per day, and water temperatures varied from 10° to 18° C. during the experiment. Samples of 50 fish were obtained in all instances except one in which only 40 trout were landed on No. 2 hooks. The total short-term mortality was 13.5 per cent, i.e., 66 of 490 hooked trout. Losses were observed throughout the 14-day holding period, but 71 per cent occurred within 24 hours after hooking. No control fish died throughout the processing and holding period. Pathogenic organisms were not detected in any of the fish that died. Thus, hooking-related injuries were the probable cause of death in this part of the study.

Two-thirds of all the fish caught were lightly hooked (Table 1), and the proportion varied less than 10 per cent among the hook sizes tested. Depth of hooking was not biased by the number of anglers, lightly hooked fish amounting to 66.2 per cent when two people fished and 67.5 per cent when one person fished. Most lightly hooked fish were caught in the jaw (64.8 per cent) or roof of the mouth (30.6 per cent). Fewer than 5 per cent were hooked in the tongue. Differences in the degree of mortality associated with hooking location and manner of handling were tested by chi-square, using Yates' correction for continuity (Zar, 1974) when appropriate. The mortality of lightly hooked trout (0.9 per cent) was not significantly different from that of the control fish (Table 2). Handling with wet or dry hands had little effect on mortality; two of those that died had been handled with dry hands and one with wet hands.

The over-all mortality of deeply hooked trout was 38.7 per cent. Short-term survival was significantly increased by clipping the leader (Table 2), mortality being 59.0 per cent when hooks were removed but only 17.5 per cent when leaders were clipped (Table 1). The most common hooking locations among deeply hooked fish were the esophagus/stomach (46.6 per cent) and gills (39.6 per cent), while 13.5 per cent were hooked in the eye. Survival of fish hooked in the gills or esophagus was significantly higher

TABLE 1. SHORT-TERM* MORTALITY OF SPRING YEARLING BROWN TROUT CAUGHT ON WORM-BAITED HOOKS OF DIFFERENT SIZES ACCORDING TO HOOKING LOCATION AND MANNER OF HANDLING

Hooking location and manner of handling	Hook size											
	2		4		6		8		10		Total	
	Number§	Per cent	Number§	Per cent	Number§	Per cent	Number§	Per cent	Number§	Percent	Number§	Per cent
Lightly hooked												
Upper / lower jaw												
Dry hands	0 (18)	0.0	1 (14)	7.1	0 (23)	0.0	0 (22)	0.0	0 (26)	0.0	1 (103)	1.0
Wet hands	1 (20)	5.0	0 (21)	0.0	0 (18)	0.0	0 (23)	0.0	0 (27)	0.0	1 (109)	0.9
Roof of mouth												
Dry hands	0 (14)	0.0	0 (15)	0.0	0 (8)	0.0	0 (12)	0.0	0 (5)	0.0	0 (54)	0.0
Wet hands	0 (8)	0.0	0 (10)	0.0	0 (11)	0.0	0 (12)	0.0	0 (5)	0.0	0 (46)	0.0
Tongue / isthmus												
Dry hands	0 (3)	0.0	1 (3)	33.3	0 (1)	0.0	0 (0)	0.0	0 (1)	0.0	1 (8)	12.5
Wet hands	0 (1)	0.0	0 (1)	0.0	0 (3)	0.0	0 (1)	0.0	0 (1)	0.0	0 (7)	0.0
Sub-total	1 (64)	1.6	2 (64)	3.1	0 (64)	0.0	0 (70)	0.0	0 (65)	0.0	3 (327)	0.9
Deeply hooked												
Esophagus / stomach												
Hook removed	2 (2)	100.0	4 (5)	80.0	5 (6)	83.3	10 (10)	100.0	5 (7)	71.4	26 (30)	86.7
Leader clipped	2 (5)	40.0	5 (5)	100.0	1 (11)	9.1	1 (13)	7.7	0 (12)	0.0	9 (46)	19.6
Gills												
Hook removed	1 (5)	20.0	8 (11)	72.7	6 (9)	66.7	2 (3)	66.7	5 (10)	50.0	22 (38)	57.9
Leader clipped	0 (6)	0.0	4 (9)	44.4	0 (4)	0.0	0 (2)	0.0	1 (6)	16.7	5 (27)	18.5
Eye												
Hook removed	1 (6)	16.7	0 (4)	0.0	0 (4)	0.0	0 (1)	0.0	0 (0)	0.0	1 (15)	6.7
Leader clipped	0 (2)	0.0	0 (2)	0.0	0 (2)	0.0	0 (1)	0.0	0 (0)	0.0	0 (7)	0.0
Sub-total	6 (26)	23.1	21 (36)	58.3	12 (36)	33.3	13 (30)	43.3	11 (35)	31.4	63 (163)	38.7
Total	7 (90)	7.8	23 (100)	23.0	12 (100)	12.0	13 (100)	13.0	11 (100)	11.0	66 (490)	13.5

*14 days immediately after fish was caught.

§Figures in parentheses represent number caught in each case.

TABLE 2. SIGNIFICANCE OF DIFFERENCES IN DEGREE OF MORTALITY OF SPRING YEARLING BROWN TROUT CAUGHT ON WORM-BAITED HOOKS, ACCORDING TO VARIOUS COMBINATIONS OF HOOKING LOCATION, HOOK SIZE AND MANNER OF HANDLING§

Comparison	Value of chi-square†
General	
All hooked fish vs. control fish	75.12**
Lightly hooked fish vs. control fish	3.59
Deeply hooked fish vs. control fish	307.08**
Lightly hooked fish vs. deeply hooked fish	194.77**
Fish taken on No. 4 hooks vs. fish taken on all hooks	7.00*
Deeply hooked fish	
Leader-clipped fish vs. fish with hooks removed	
All hooking locations	55.37**
Hooked in esophagus	173.59**
Hooked in gills	15.60**
Fish taken on No. 4 hooks vs. fish taken on all hooks; hooks removed in both cases; all hooking locations	0.02
Fish taken on No. 4 hooks vs. fish taken on all hooks; hooks leader-clipped in both cases	
All hooking locations	14.07**
Hooked in gills	2.46
Hooked in esophagus and gills	15.63**

§During 14-day period immediately following capture. See text for hook sizes tested and sampling procedure.

†One degree of freedom in each case. Values not noted by asterisk not significant.

*Significant at 0.01 level of probability.

**Significant at 0.001 level of probability.

when the leaders were clipped (Table 2), but clipping the leader did not affect the survival of eye-hooked fish.

Hook size influenced mortality, rate of capture and the incidence of eye-hooking. Fish caught on No. 4 hooks had a significantly higher mortality than those caught on hooks of the other sizes. This was primarily due to poor survival of leader-clipped fish hooked in the esophagus/stomach or gills (Table 2). The time required to catch 50 fish was positively correlated with hook size ($r = 0.690$), large hooks (Nos. 2 and 4) being less efficient than small hooks (Nos. 8 and 10). Larger hook size was also correlated with the occurrence of eye-hooking ($r = 0.972$).

Sub-lethal injuries were present in about half of the lightly hooked trout, the predominant one being a rupture in the thin tissue between the maxillary and premaxillary bones. Small scars on the jaws, tongue or roof of the mouth were common. Severely torn mandibles or premaxillaries were found in fewer than 10 per cent of such fish.

Deeply hooked fish were injured more severely than lightly hooked fish. One eye was partially filled with blood in 80 per cent of the eye-hooked fish. Injuries were less common in gill-hooked trout; torn gill arches or scars near the isthmus were found in one-third of these fish. Eye and gill wounds were present in both leader-clipped and hook-removed specimens. Possible internal injuries in fish hooked in the esophagus or stomach were not assessed.

Six hooks were observed on the bottom of the aquaria at the conclusion of the short-term phase of the study.

LONG-TERM EFFECTS

Over-summer survival of the leader-clipped trout was 56.6 per cent (30 of 53 fish). Although clipped fins regenerated extensively during the summer, 19 trout had recognizable marks in October. Of these, 15 had been hooked in the esophagus/stomach and four in the gills. Eleven fish could not be identified by fin clips, but were known to have been leader-clipped specimens because of their length. Failure to recognize marks on all fish precluded determination of survival rates for the different hooking locations.

Leader-clipped trout were able to obtain food and grow while being held at the Van Hornesville hatchery. Their mean condition factor (K) was 1.004 ± 0.103 when they were placed in the pond in July and 1.261 ± 0.125 when the survivors were examined in October. Portions of hooks were found in seven of the survivors, four in the stomach and three in the esophagus. In five instances hooks were removed that had not decomposed substantially, and all five included a portion of the leader material. Two hooks, both found in the anterior part of the stomach, were severely eroded, the shank being approximately half the normal length. Sizes of hooks recovered were No. 6 (two hooks), No. 8 (two hooks) and No. 10 (three hooks). No pattern was evident between degree of decomposition and hook size.

Of the leader-clipped trout being held during this period, 10 died in the DeBruce holding tank and two died in transit from DeBruce to Van Hornesville. The dead specimens recovered from the Van Hornesville pond were partially decayed and dessicated when examined; only five fin-clipped trout were recognized. Hatchery personnel reported that most of the mortality took place within the first week the fish were in this pond. The largest rainbow trout reportedly killed, but did not consume, some of the experimental fish shortly after they were introduced. These attacks ceased after one week.

DISCUSSION

The total short-term hooking mortality of brown trout in this study (13.5 per cent) was less than that found in most previous work where hooks were removed from salmonids. However, it can be inferred from the data that, if the hooks had been removed by hand from all the deeply hooked fish, this mortality would have been about 22 per cent. Shetter and Allison (1955) reported a mortality of 20 per cent for wild brown trout caught in Michigan streams on No. 8 hooks baited with worms. In their studies, mortality of similarly caught brook trout and rainbow trout was approximately twice that of brown trout. Mason and Hunt (1967) examined the hooking

mortality of worm-caught rainbow trout that were deeply hooked in the mouth and found that nearly 90 per cent died after the hooks were removed. Warner (1976) recorded a 6 per cent mortality of landlocked salmon (*Salmo salar*) taken on worms, but few of the fish were deeply hooked.

Evidence from the present study, and others, indicates that the location of hooking is extremely important with respect to the survival of trout caught on natural baits. Fish hooked in the anterior area of the mouth generally suffer a mortality of less than 10 per cent, whereas losses can exceed 50 per cent among fish that are hooked in the gills, esophagus or stomach (Shetter and Allison, 1955; Mason and Hunt, 1967; Hunsaker et al., 1970). Shetter and Allison found the incidence of throat- and gill-hooking to be 25 per cent for worm-caught brown trout, but higher for brook trout and rainbow trout. In the present study, the proportion of brown trout caught in the gills or esophagus/stomach ranged from 20 to 35 per cent for the hooks sizes tested. Shetter and Allison autopsied many of the dead brook trout they recovered. In most cases, the fatal wounds they attributed to "throat hooking" were caused by penetration of the hook into the heart. Other major causes of death included damage to the body cavity, arteries, liver and gills. Although internal injuries were not assessed in the present study, the lethal wounds for deeply hooked brown trout were probably similar to those reported by Shetter and Allison for brook trout.

Restrictions against the use of natural baits have been commonly used to reduce hooking mortality of sub-legal salmonids. Few studies have examined means of reducing such losses while still allowing the use of bait. Mason and Hunt (1976) found that mortality among rainbow trout hooked deeply in the mouth was reduced from 95 to 82 per cent if long-nosed pliers, rather than fingers only, were used in hook extraction. Survival was greatly enhanced by clipping the leader; only 34 per cent of their leader-clipped trout died during a 4-month holding period. The data obtained for brown trout in the present study corroborate the survival value of leaving hooks in deeply hooked trout. The short-term mortality (14 days) for brown trout hooked in the esophagus or gills was 71 per cent when the hooks were removed manually compared with 19 per cent when the leaders were clipped. For the surviving leader-clipped fish hooked in these locations, mortality throughout the entire subsequent 4-5 month holding period was 54 per cent. This rate should be considered maximal, because predatory losses among these fish at the Van Hornesville hatchery may have removed some potential survivors. The mortality of eye-hooked trout was only 7 per cent when the hooks were removed, so clipped leaders did not enhance survival as dramatically as it did for the other deeply hooked trout.

The value of clipping leaders would be reduced if hook retention impaired feeding and growth. Mason and Hunt (1967) reported that gains in length and weight among their leader-clipped rainbow trout held under

hatchery conditions were not significantly different from those among unhooked controls. This type of comparison was not made in the present study, but the leader-clipped survivors appeared to be in good physical shape and had high condition factors when they were examined in October. Although hook retention could have prevented feeding in some instances, it is clear that many leader-clipped trout were able to feed and grow during the summer.

Shedding or decomposition of hooks may contribute to the successful feeding and growth of leader-clipped trout. More than half of the leader-clipped survivors in Mason and Hunt's study, and in the present one, were able to rid themselves of the hook by the end of the holding period. In both studies, hooks were found in the holding tanks and in fish autopsied at the conclusion of the experiment. Many hooks, however, could not be accounted for. Mechanisms for possible hook loss from deeply hooked fish include gastric digestion, direct passage through the opercular aperture and movement through either end of the digestive tract. Mason and Hunt did not elaborate on the fate of recovered or lost hooks. In the present study only two leader-clipped survivors contained hooks that were obviously eroded, both being in the cardiac portion of the stomach. Hooks located in either the esophagus or pyloric region of the stomach showed little sign of decomposition. Secretion of gastric hydrochloric acid occurs principally in the cardiac region of the stomach in salmonids (Barrington, 1957), so hooks embedded there could decompose more rapidly. Hooks were not found in any of the eye- or gill-hooked brown trout examined in October. Opercular respiratory movement could dislodge hooks from the gills, but active "removal" of a hook from the eye is not likely. Under the experimental conditions in this study, it was not possible to determine the actual hook loss associated with each of the possible mechanisms.

The effect of hook size on the mortality of leader-clipped trout is not known to have been investigated prior to this study. It is uncertain why the survival of leader-clipped fish hooked in the gills or esophagus/stomach with No. 4 hooks was lower than that observed for the other hook sizes. No correlation between hook size and mortality could be determined. Morphometric characteristics of the mouth and gullet may contribute to the relationship of hook size or style to lethality in different sized fish. Further study would be required to determine the causes of mortality in leader-clipped fish and the relationship of hook size to that mortality.

The results from this study showed that the act of hooking and quickly landing a fish was a minor source of mortality for the brown trout tested. Lethal injuries occurred most often when hooks were removed from the upper digestive tract or gills. If the leaders had been clipped on all deeply hooked trout, the short-term mortality would have been about 7 per cent for all trout hooked during the experiment. Factors such as time of year, strain of fish and water conditions may affect the proportion of fish that are deeply hooked in natural fishing situations, but the survival value of

clipping leaders in similarly sized, deeply hooked trout should still pertain to actual fishing conditions. Legislation requiring that leaders be clipped on sub-legal deeply hooked trout could not be enforced. However, voluntary practice of this technique by bait fishermen could result in a substantial reduction in the loss of under-sized brown trout (and probably other salmonids) and ultimately in better angling for legal fish later in the season.

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DEER WINTERING AREAS AND WINTERING HABITS OF DEER IN THE TOWN OF MALONE[1]

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ABSTRACT

Aerial surveys were made each winter from 1969-70 to 1973-74 to locate deer concentrations in the Town of Malone and vicinity. Two perennial wintering areas, two one-year wintering areas and 17 activity areas were located. The two perennial areas were the primary source of data for comparing deer activity patterns and browse use. Implications of these comparisons are given. Both deer activity and browse use were closely related to the severity of the winter and particularly to periods of snow depth in excess of 20 inches. A total of 19 deer trapped and ear tagged in the Deer River wintering area. Seven of these, all males, were recovered. The implications of data on deer movement are discussed.

As part of a general investigation of deer *(Odocoileus virginianus)* ecology and management problems in the Town of Malone (in Franklin County, N.Y.) studies were carried on to locate deer wintering areas and to determine the mobility of deer in these areas and the degree to which available browse was being used. The study area included the entire Town of Malone and a 2-mile-wide strip around it and comprised 105 square miles (Figure 1). The work was done between October 1, 1969 and March 31, 1974.

PROCEDURES

Except for the aerial surveys, field work was done by two special game protectors and the data were forwarded to the authors. Activities came under the major headings of weather observations, aerial surveys, ground surveys, and deer trapping and tagging.

Weather Observations

Since weather is a major influence on deer mobility during the winter in the Adirondack region (Severinghaus and Free, 1963; Jackson, 1969) a special effort was made to document weather conditions on the study area. Records of snow depth and condition, wind direction and velocity, and temperature were made at the homes of the special game protectors at 8:00 a.m. daily from the beginning of the legal deer season to April 30 each

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-89-R. Special thanks are due Stanley Stickles and Lyndon Raville, the special game protectors who made the field surveys and recorded the data, and their supervisor, Conservation Officer H. F. White. Malcolm Orcutt, principal fish and wildlife technician in Region 5, was the observer on aerial flights and did an excellent job of reporting these surveys as well as assisting on ground surveys.

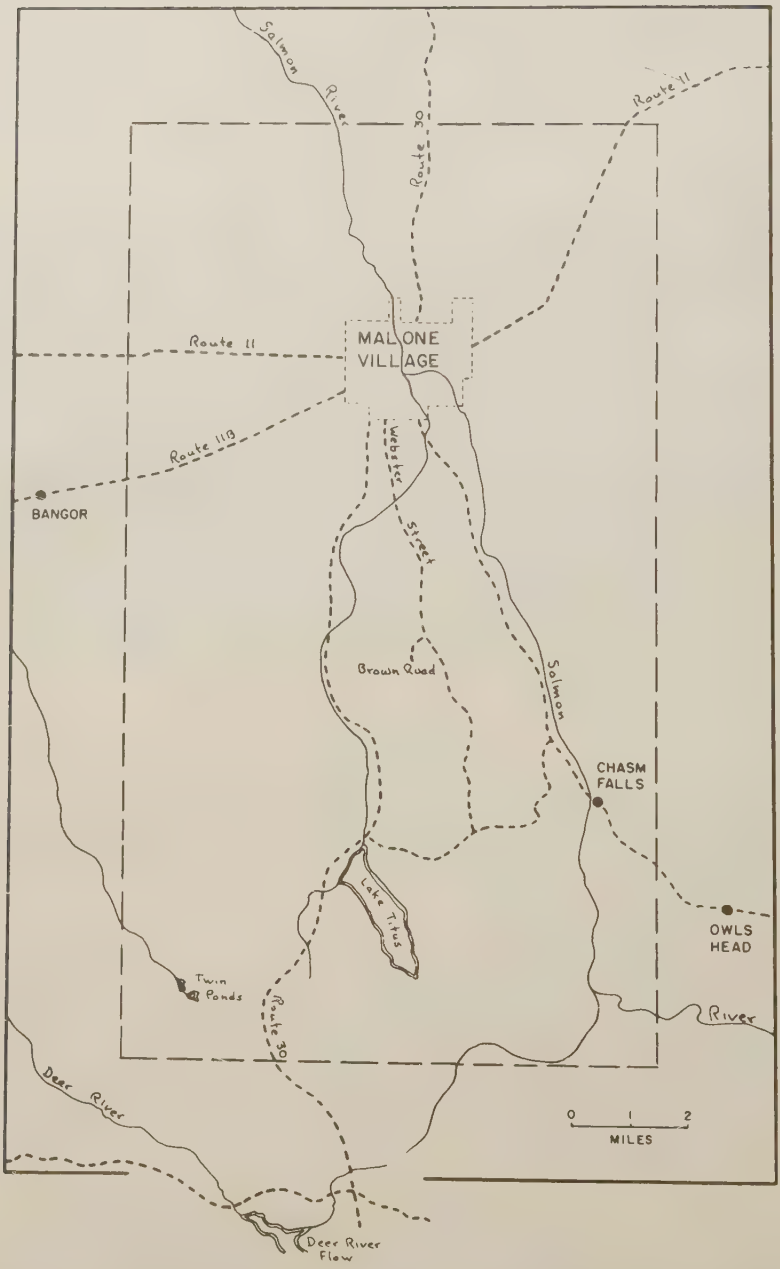

Figure 1. Map of study area, comprising Town of Malone (long-dash line) and 2-mile-wide strip surrounding it (solid line) plus area in vicinity of Deer River Flow.

year. Data from Stickles' home in Malone Village were representative of the northern part of the Town, while data from Raville's home in Chasm Falls were more characteristic of the southern part.

AERIAL SURVEYS

To locate winter deer concentrations in the 105-square-mile study area, a fast, efficient method of observation was needed. Snow conditions in northern New York can change abruptly, and the only mode of transportation allowing complete coverage of the area within one or two days was aircraft. Therefore, arrangements were made for aerial surveys to be made with a private airplane (Cessna 182) and pilot based at the Malone Airport, except for a few occasions when a Department helicopter from Albany was used.

These surveys were begun each winter following the first 6-inch snowfall, and subsequent surveys were made at 2- or 3-week intervals if substantial changes in the weather occurred. Such changes included major accumulations of snow, a change in crust conditions or a major thaw, all of which would affect deer mobility. When optimum flying conditions failed to materialize, flights were often made anyway in order to obtain some information. Variables, particularly in the condition of the snow surface and wind, frequently affected track visibility in parts of the study area and partial flights were made. Flights were cancelled if skies were overcast, surface conditions obscured tracks, wind exceeded 11 knots or snow was falling or had fallen within 12 hours. Air sickness of the observer sometimes caused a flight to be aborted. Flights were discontinued when the deer concentrations broke up in the spring.

Flight lines were spaced 2,000 feet apart. In the beginning they were oriented north and south, but during the winter of 1973-74 east-west lines were used to reduce the effect of prevailing westerly crosswinds. The entire study area was flown over at least once early in the winter at an elevation of between 200 and 500 feet on clear or partly cloudy days when snow conditions made tracks visible. During open winters (1971-72, 1972-73 and 1973-74) when deer movement was not restricted, subsequent flights were made only when weather patterns changed. During the severe winters of 1968-69[2], 1969-70 and 1970-71, however, deer were restricted or confined for several weeks in a limited number of areas. When this occurred, surveys of such areas were made at elevations of between 100 and 200 feet along flight lines about 1,000 feet apart. Under these flying conditions, activity patterns of the deer could be observed and deer could often be seen feeding or bedded down. However, native (brown) deer cannot be censused accurately from the air (Hesselton, 1973). On all surveys, a flight record was kept and the observer, a wildlife technician, recorded track locations on topographic maps of the area. These maps were used later by the observer

[2]Based on prior observations reported by Jackson (1969).

and the two special game protectors to confirm track locations on the ground.

Ground Surveys

Each flight was followed immediately by a ground reconnaissance to confirm the presence of deer at locations where tracks had been seen from the air. An effort was made to check these areas within a day or two of the flight and before weather changes made deer sign (particularly tracks and beds) difficult to detect. Observers travelled by snowmobile, snowshoes or on foot, and the track area as noted from the air was circled on the ground. If deer were absent this was indicated on the aerial report. Where deer were present and obviously staying in the area, data were recorded concerning the crust condition, snow depth in softwoods and hardwoods, depth to which deer sank in the snow, deer activity patterns, browse species present and degree of use by deer or snowshoe hares. Comments were also included on human activity, activity and impact of other wildlife species, impact of natural events such as blowdown, fire or flooding, and any other historical events that may have influenced the ecology of the area. Estimates of browse use were always made by two observers working together.

After two winters of surveys, it was concluded that there were only two perennial deer wintering areas on the study area. One was nearly in the geographical center of the Town of Malone and was named the Brown Road wintering area. The other was on the southern boundary of the study area along the Deer River and was named the Deer River wintering area. Therefore, these were considered the key localities for documenting deer activity and browse use throughout the study. Surveys were made in these areas at about 2-week intervals during the winter each year. Routes for each survey were determined from records of recent deer activity. In the area of most recent activity, any deer trails within one-quarter to one-half mile of its center were followed and observations relating to deer movement were noted. Records of snow depth were the average of six actual measurements. Appraisal of browse use was an occular estimate for each browse species of the degree to which the current annual growth had been eaten by deer. Actual measurement was not deemed feasible or necessary for this study since the degree of browsing was more important than strict comparison of actual use between individual plants or species. Use categories recognized were light, moderate, heavy and extreme (Jackson, 1970). The observers had been trained in browse identification and worked closely with a professional biologist in estimating the amount of current use before recording such data by themselves.

Deer Trapping and Tagging

There are two principal ways of monitoring seasonal activity of deer:

radio telemetry and tagging individual animals. Both were investigated at the beginning of this study. However, because of a reduction in funding and other administrative problems, it became necessary to drop consideration of telemetry.

Attempts to trap deer, using five modified Michigan box traps, had been begun in the winter of 1968-69 (Jackson, 1969) and were continued in 1969-70 in two known wintering areas, Brown Road and Studley Hill. The traps were baited at different locations and times with alfalfa, apples, molasses, Omaline (commercial food mix of grains and molasses) or combinations of these foods. However, although they approached baited traps in both areas, the deer refused to enter. The top of one of the wooden traps was replaced with a rope net to illuminate the interior, but deer still were not caught. A final effort included the use of salt as bait in May and June but was also unsuccessful. The deer would eat the bait leading up to a trap but would not enter it. Obviously, it takes hunger to overcome the fear of entering an enclosed trap. Apparently, those in the vicinity of the traps in these areas had an abundance of preferred food in the form of apple, basswood, sumac and white cedar available to them.

Following this, these traps were moved to the Deer River wintering area where they were operated during the winter of 1970-71 and, with 12 additional ones, in 1971-72 and 1972-73. Alfalfa was the primary bait and proved satisfactory in catching deer because overbrowsing had depleted the natural food supply in this area. Deer caught in the box traps were tagged with a monel metal tag in each ear plus a color-coded plastic streamer in one ear to help identify the animal in the field. Tag numbers and position, sex and age of the animal, the date of trapping and trap number were recorded.

FINDINGS

Results of the study are presented with respect to weather, deer wintering areas and deer movement.

WEATHER

The effects of winter weather on deer populations are known to be significant. Data taken at the two locations on the study area are summarized in Table 1 under five categories for the period of December through April each year. Average monthly temperatures each year are given in Table 2. Data in both tables indicate that the winters of 1969-70 and 1970-71 were severe, while that of 1971-72 was about average and 1972-73 was quite mild. Temperature data for 1973-74 were not complete; however, average temperatures for December and January were 2 to 6 degrees above the 5-year average and those for February and March were 3 to 7 degrees below it, indicating a 4-month average slightly below the

Table 1. Summary of Weather Data Recorded at Two Locations in the Town of Malone During the Winters of 1969-70 to 1973-74*

Item	1969-70		1970-71		1971-72		1972-73		1973-74	
	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls
Number of days with freezing temperatures	118	129	131	125	112	106	96	88	92	90
Number of days with sub-zero temperatures	10	26	14	24	9	12	11	21	17	18
Number of days with strong winds and freezing temperatures	24	35	20	35	25	29	8	26	13	17
Number of days with strong winds and sub-zero temperatures	1	5	0	1	1	3	0	2	0	0
Number of days deer movement severely limited by snow depths in excess of 20 inches	35	65	88	93	27	22	0	0	0	0

*Represents period from December through April each year.

Table 2. Average Monthly Temperatures (in degrees Fahrenheit) Recorded at Two Locations in the Town of Malone During the Winters of 1969-70 to 1973-74*

	December		January		February		March		April		Average	
Winter§	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls	Malone	Chasm Falls
1969-70	19.3	13.2	6.0	-4.1	15.9	14.5	22.9	21.9	37.9	31.7	20.4	15.4
1970-71	14.3	11.9	9.1	4.0	18.1	16.0	21.7	20.8	30.3	34.7	18.6	17.4
1971-72	20.2	23.5	19.4	18.7	7.9	10.8	22.1	25.8	31.3	34.6	20.3	22.8
1972-73	18.7	21.8	18.1	10.8	13.4	7.6	35.3	36.7	40.4	39.4	25.3	23.5
1973-74+	22.6	24.3	15.8	17.7	10.3	7.7	21.6	17.9	..	..	..	..
Average	19.0	19.0	13.7	11.1	13.1	11.3	24.3	24.8	35.0	35.1	..	..

*Readings taken at 8:00 a.m. daily.
§Represents period from December through April each year.
+Recordings terminated on March 28.

5-year mean, while snowfall through March 28 was much less than average.

There were differences in the data at the two recording locations. Conditions at Malone Village (population about 9,000) were influenced by the urban environment. Interestingly, although daily temperatures there were frequently lower than those at Chasm Falls, Chasm Falls experienced more temperature extremes particularly sub-zero readings. This was reflected in the differences in average monthly temperatures for January and February at the two locations, while those for the other months were quite close. Likewise, average snowfall was greater at Chasm Falls, and snow tended to remain longer since daily temperatures, particularly during January and February, were lower. A departure from this pattern occurred in 1971-72 when temperature inversions over the Village of Malone were frequent. On several occasions cloud cover persisted throughout the day, thus reducing solar heating effects and resulting in 8:00 a.m. temperatures being lower than those at Chasm Falls during the months of December, February, March and April. Thus, in that winter, the number of days when deer movement would have been limited by snow depth was greater in the vicinity of Malone Village (27) than in the vicinity of Chasm Falls (22). The vast majority of deer wintering on the study area were subject to conditions similar to those at Chasm Falls which is closer to the more heavily used Deer River area.

The most significant relationship between climatic conditions and wintering deer populations is the effect of snow depth (especially depths at which deer sink over 20 inches) on deer movement in their yarding areas and vicinity. During the severe winters of 1969-70 and 1970-71 deer on the study area were confined to a smaller portion of their annual range than in other winters, and the periods of confinement were longer. Total snowfall was not so important in this respect as was the duration of accumulated snow at depths in which deer sank over 20 inches. While there was generally a close relationship between lower temperatures and increasing snow depth, deer did not move *en masse* to traditional wintering areas after a snow accumulation of 12 inches or more. Subsequent activity in wintering areas was closely related to snow depth and condition.

Temperature and wind when combined with substantial snow depth were important influences in forcing deer to seek softwood shelter in traditional wintering grounds (i.e., Deer River and Brown Road). However, when snow depth was not a factor, deer travelled widely throughout the study area although they would seek the nearest softwood shelter apparently to avoid excessive heat loss during cold spells with high winds.

Deer Wintering Areas

The number of locations where deer wintered was directly related to the severity of the winter (Figure 2), the more severe the weather, the fewer the areas in which deer congregated. When more areas were used, fewer deer

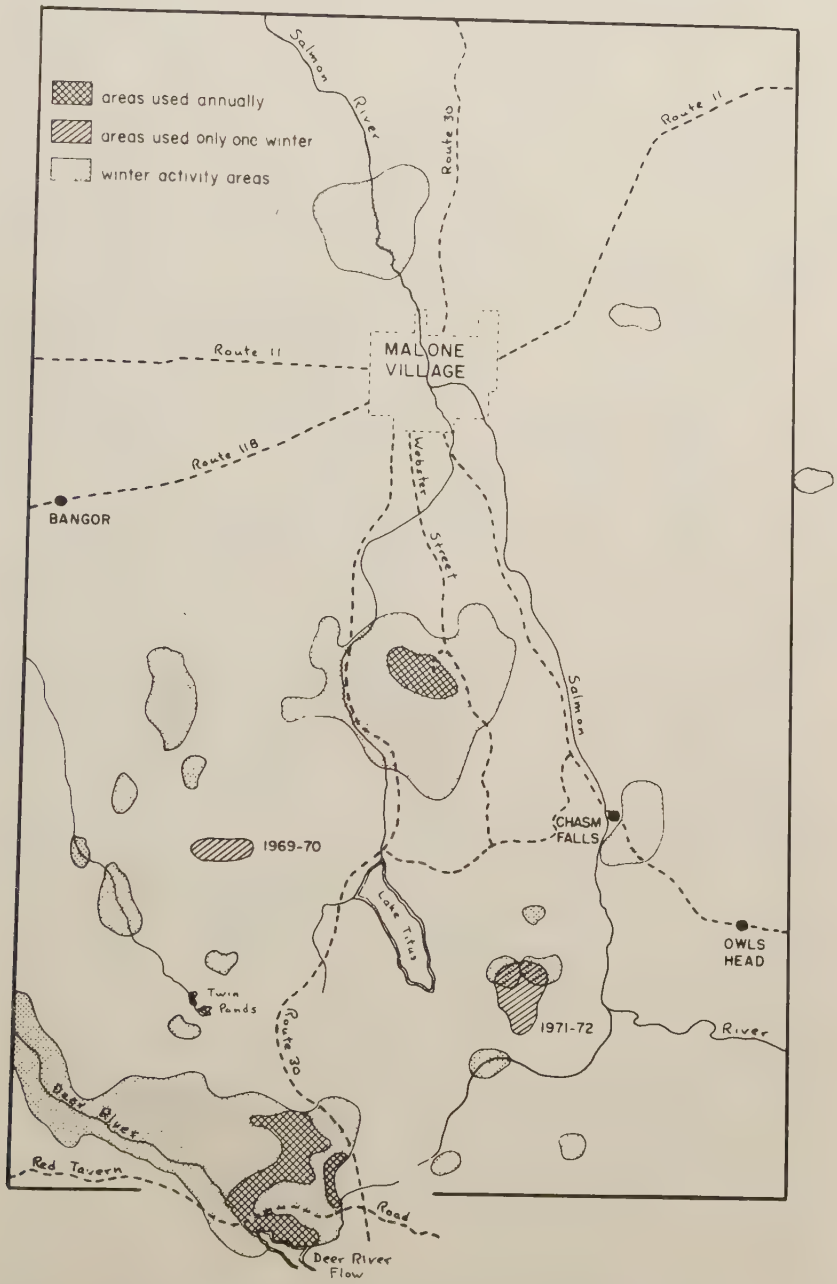

Figure 2. Map of study area showing deer wintering areas used annually and those used only one winter, together with winter activity areas frequented in mild winters.

Table 3. Relationship Between Number of Deer Activity Areas Located During Aerial Surveys and Snow Conditions of the Study Area

Winter	Date of survey	Number of areas located*	Snow condition		
			Depth (inches)	Type	Crust
1969-70	January 6	6	30	Wind-blown powder	None
	January 19	4	12-33	Wind-blown powder	None
	February 9	4	21	Packed powder surface	Breaking
	February 27	2	33-42	8-12 inches powder on 25-30 inch base	Non-supporting
	March 15	2	40	2 inches powder on packed surface	Non-supporting
1970-71	December 31	7	40-50	Powder	None
	January 6	7	20-40	Frozen granular	Non-supporting
	January 19	2	38	4 inches powder on crust	Breaking
	April 9	2	39	Frozen granular surface	Supporting
1971-72	January 18	5	8	Wet powder	None
	February 8	3	16	3 inches powder on crust	Non-supporting
	March 6	6	34	4 inches powder on crust	Supporting
1972-73	December 12	9	3-5	Wet powder	None
	January 2	5	8-12	Packed powder	None
	January 17	4	12	6 inches light powder on packed powder base	None
	January 25	3	2	1 inch powder on frozen granular	Non-supporting
1973-74	January 17	2	14	8-11 inches wind-blown powder on packed powder	None
	February 9	2	2	1 inch powder on frozen granular	Supporting
	February 27	4	1-3	Wind-blown powder	None
	March 26	6	10	Wet powder	None

*Numbers not absolute since several flights did not completely cover the area.

occupied each one. Only two were used in every winter during the study period, Brown Road and Deer River. The pattern varied throughout the winter depending on snow depth and crust condition (Table 3). As snow depth increased, activity areas became fewer until a supporting crust formed or a thaw reduced snow depth below 20 inches. That the data for aerial observations on certain dates (January 19 and April 9 in 1971, January 25 in 1973, and January 17 and February 9 in 1974) seem contradictory is attributable to the fact that, although snow conditions on these dates permitted deer to move freely, unfavorable ground conditions made it difficult to see deer tracks. Thus deer appeared to be more confined than they actually were.

A distinction should be made between deer wintering areas and deer activity areas. Deer wintering areas are defined (Eabry, 1970) as areas where deer concentrate during winter months for ease of travel and comfort for one or more winters and which may or may not offer a food supply. Since many of the places where deer congregated on the study area were not used through an entire winter, the authors prefer to call them activity areas. In

any given winter, these areas were frequented by deer on one or more occasions but for only a few days at a time. The areas of both types recognized on the study area are shown in Figure 2. Two wintering areas were used throughout each winter and two were used for one winter only, whereas 17 activity areas were frequented at various times.

Some general comments are in order regarding wintering areas and activity areas. The activity areas depicted in Figure 2 represent observations on the particular days when aerial surveys were made. Ground reconnaissance of these areas revealed that, while deer were present at the time of the aerial flights, deer sign was scant and browsing light. Thus deer were staying in the area for a short time or only passing through. If the flights had been made on other dates the activity areas would probably have been different. During the winters of 1969-70, 1970-71 and 1971-72 the activity areas were fairly representative of where deer were during those winters. However, during the extremely open winters of 1972-73 and 1973-74, deer were able to travel virtually anywhere and the activity areas would vary from day to day. Two areas, Childs Brook and Thomas Swamp, were used by deer throughout the winter in only one year. Two or three deer were found in the Childs Brook area in the winter of 1969-70, but although the area was carefully observed in subsequent winters deer were never seen there again. The Thomas Swamp area held several deer during the winter of 1971-72 and in subsequent winters activity was observed in the vicinity but deer were not confined to the swamp. The two perennial wintering areas, Brown Road and Deer River, were complex and contained many deer. The activity pattern varied (Figure 3) with the severity of the winter. Interestingly, deer stayed in or near these areas even during the mild winters of 1972-73 and 1973-74.

OCCASIONAL WINTERING AREAS The Childs Brook drainage and Thomas Swamp may be considered in this category. Following is a description of each of these areas and a summary of observations on deer activity and browse use.

In 1969-70 two or three deer spent the winter in the upper part of the Childs Brook drainage. The area is remote, at least 2 miles from any human dwelling, and lies in a narrow basin flanked by quite steep hills that provide protection from prevailing winds. Softwood cover was limited to small pockets of white cedar (*Thuja occidentalis*) and balsam fir (*Abies balsamea*) an acre or less in size. The area was visited on February 4 and 18. On February 4 the deer were in a small pocket of white cedar where they appeared to have been for several days. Browsing of current annual growth was extreme on the white cedar, moderate to heavy on red maple (*Acer rubrum*), moderate on wild raisin (*Viburnum cassinoides*), silky dogwood (*Cornus amomum*), red osier dogwood (*Cornus stolonifera*), striped maple (*Acer pennsylvanicum*) and basswood (*Tilia americana*) and light on wild apple (*Pyrus* sp.), round-leaved dogwood (*Cornus rugosa*), American elm (*Ulmus americana*) and yellow birch (*Betula lutea*). By

Figure 3. Map of Brown Road wintering area and vicinity (above) and Deer River wintering area and vicinity (below) showing extremes of deer activity pattern, i.e., from restricted on February 11, 1971 (within solid lines) to loosely concentrated throughout the winter of 1972-73 (within dash lines).

February 18 the deer had moved and, although they were still in the general area, browse use was not as heavy as in the area surveyed on February 4. Browsing was extreme on white cedar and heavy on red maple wherever deer travelled, but that on striped maple, witchhobble (*Virburnum alnifolium*), wild raisin, red osier dogwood, sugar maple (*Acer saccharum*) and yellow birch was light. The three deer appeared to have little impact on species other than white cedar and red maple. Snow was deep in the hardwoods surrounding the softwood pockets during most winters and definitely limited deer movement. The combination of steep terrain, limited softwood cover and deep snow in the hardwoods limited the potential of this area for over-wintering deer.

Deer were discovered in the Thomas Swamp area in the winter of 1971-72 during a ground reconnaisance on snowmobiles. The area is situated at the base of the Titusville Mountains at the head of a drainage into Huckleberry Swamp, and a State forest plantation borders it on the east and south. Deer were taking advantage of planted Norway spruce (*Picea abies*) and red pine (*Pinus resinosa*) and native balsam fir as cover. The area was surveyed on February 5, 6 and 15, March 7 and April 4. Witchhobble and red maple were abundant and readily used by deer. White cedar, striped maple, basswood, red osier dogwood, alternate-leaved dogwood (*Cornus alternofolia*), wild raisin, yellow birch, sugar maple, black cherry (*Prunus serotina*), beech (*Fagus grandifolia*), aspen (*Populus* sp.), gray birch (*Betula populifolia*) and balsam fir were also present and had received light browsing. Snow depths that allowed deer to sink over 20 inches existed from February 20 through March 15 during which time deer were restricted primarily to softwood cover. About six to eight deer wintered in the area in 1971-72 and were observed in the vicinity during two subsequent winters. However, mobility was unlimited during the winters of 1972-73 and 1973-74 and only fringes of the actual concentration area were used. The area was considered to have the potential for holding greater numbers of deer in later winters. Other species having an impact on the habitat were beaver that had flooded part of the area in previous years and snowshoe hares that lived in the Norway spruce and balsam fir and competed with the deer for woody browse.

PERENNIAL WINTERING AREAS The areas in this category, Deer River and Brown Road, became the key areas for documenting deer activity and browse use over the study period. They presented a strong contrast in physical characteristics (Table 4).

The Deer River area was characteristic of wintering areas in the central Adirondacks. Primary cover was even-aged balsam fir and red spruce (*Picea rubra*) in swamps or along drainages. Over 100 deer had used the area for many years and during periodic severe winters had been confined on a small portion of their annual range. Browse available to deer had been decreasing for about 40 years, due to lack of cutting and the gradual maturation of the forest which resulted in a closed canopy. Plants of value

TABLE 4. COMPARISON OF DEER RIVER AND BROWN ROAD WINTERING AREAS

Item	Deer River	Brown Road
Location	Along and adjacent to Deer River Flow in northwestern corner of Town of Duane; within Adirondack Park; about 90 per cent private land	Almost in geographic center of Town of Malone; lies on either side of Brown Road; all private land
Topography	Irregular; lowlands along river and balsam fir swamps; no clear aspect	Rolling hills cut by a small drainage; aspect generally north
Drainage	North; Deer River flows into St. Regis River which flows into St. Lawrence River	North; small drainage flows into Salmon River which flows into St. Lawrence River
Access	Via Route 30 and Red Tavern Road	Via Webster Street Road and Brown Road
Crown cover	Over half the area had coniferous cover composed primarily of balsam fir and red spruce; hardwoods were beech, yellow birch, sugar maple and red maple	About 25 per cent of the area had coniferous cover composed of planted red spruce and Norway spruce and native balsam fir and white cedar; a variety of permanent and temporary hardwoods were present
Age	Even aged	All ages

to deer were scarce except along woodsroads, stream banks and in occasional openings.

In contrast, the Brown Road area, which was once an active farm that had been gradually abandoned over a 25-year period, afforded a variety of species and age classes that occurred in a random pattern throughout. Included in this diverse pattern were softwood plantations, apple orchards, hardwood stands, fallow fields with temporary and permanent hardwoods and a half-dozen fields only recently abandoned. Only about 15 to 20 deer used the area each winter.

Activity patterns of deer observed on periodic surveys in both wintering areas were recorded as concentrated, restricted or confined according to the definitions of Free (1962). The patterns varied throughout the course of each winter depending on snow depth and crust conditions. Deer congregated in both areas following the first major snowfall accompanied by a period with temperatures below freezing. Patterns became restricted when snow depths exceeded 15 to 20 inches, as well as when a breaking or nonsupporting crust made it difficult for deer to travel. Deer became confined to the softwood cover when snow depths forced them to travel in trails. Activity patterns over the five winters are shown in Table 5.

Only during the winters of 1969-70, 1970-71 and 1971-72 were deer restricted or confined in either area. The activity patterns represented movement on the day of observation only. A comparison of these patterns with the weather data in Table 1 reveals the close relationship between deer movement and snow depth in excess of 20 inches. These data indicate

TABLE 5. WINTER ACTIVITY PATTERNS OF DEER IN THE DEER RIVER AND BROWN ROAD AREAS

Winter	Deer River		Brown Road	
	Date	Pattern*	Date	Pattern*
1969-70	..	..	January 20	Concentrated
	..	..	February 15	Concentrated
	..	..	March 17	Restricted
1970-71	..	..	January 15	Concentrated
	February 11	Confined	February 11	Restricted
	February 25	Concentrated	February 25	Concentrated
	March 9	Restricted	March 9	Restricted
	March 30	Concentrated	March 30	Concentrated
1971-72	January 13	Concentrated	January 14	Concentrated
	January 30	Concentrated	February 4	Concentrated
	February 15	Concentrated	February 29	Concentrated
	March 1	Restricted	..	..
	March 19	Loosely concentrated	..	..
	April 4	Concentrated	April 5	Concentrated
1972-73	January 26	Concentrated	January 26	Loosely concentrated
	February 8	Concentrated	February 7	Loosely concentrated
	February 27	Concentrated	February 28	Concentrated
	March 15	Loosely concentrated	..	..
1973-74	January 16	Concentrated	January 11	Concentrated
	February 7	Loosely concentrated	February 4	Loosely concentrated
	February 28	Loosely concentrated	February 17	Loosely concentrated

*For definition of terms, see text.

that the winter of 1970-71 was the most severe with 88 to 93 days when the deer were restricted or confined to softwood cover. The winter of 1969-70 was second and that of 1971-72 was the least severe of the three. Snow in excess of 20 inches deep did not occur in 1972-73 and 1973-74 and deer were only concentrated or loosely concentrated throughout both these winters. There was wide flexibility in deer activity on both areas over the study period. Extremes in distribution are shown in Figure 3.

Loosely concentrated is a relative term. It was used to indicate situations where the ground was generally bare or nearly bare and a frozen granular surface allowed deer to travel freely wherever they chose. Mobility was comparable to that on summer range, but it is not known if social dictates influenced deer to return to summer habitats during these periods.

Obviously, a pattern of activity which concentrates deer on a fraction of their annual range increases the impact of browsing in the wintering areas involved. On the Deer River and Brown Road areas, estimates of the current annual growth on the browse species present were made in conjunction with surveys of the degree of use by deer. Survey routes varied but corresponded to the parts of the wintering complex where deer were present at the time. The principal species in each area (i.e., those providing most of the food for deer) and the maximum degree of use (none, light, moderate, heavy or extreme) noted each winter are given in Table 6. The browse species were grouped as preferred, second choice, readily eaten or starva-

TABLE 6. PRINCIPAL BROWSE SPECIES, ACCORDING TO DEER PREFERENCE, AND MAXIMUM USE OF CURRENT ANNUAL GROWTH OBSERVED EACH WINTER IN THE DEER RIVER AND BROWN ROAD WINTERING AREAS

	Degree of use*								
	Deer River				Brown Road				
Species	1970-71	1971-72	1972-73	1973-74	1969-70	1970-71	1971-72	1972-73	1973-74
Preferred									
White cedar	§	§	§	§	L	H	L	M	L
Apple	§	§	§	§	H	H	M	M	M
Striped maple	E	M	H	M	N	M	L	L	L
Red maple	E	M	H	M	M	L	M	M	L
Witchhobble	†	M	H	M	§	§	§	§	§
Second-choice									
Honeysuckle	‡	M	H	‡	§	§	§	§	§
Wild raisin	H	M	H	M	L	L	N	L	L
Silky dogwood	§	§	§	§	M	M	N	L	N
Round-leaver dogwood	§	§	§	L	L	L	L	L	N
Readily eaten									
White ash	‡	‡	L	L	L	N	N	N	L
Sugar maple	E	L	M	M	M	L	L	L	L
Choke cherry	§	§	§	§	M	N	N	L	N
Black cherry	E	L	M	L	M	L	L	L	N
Hazelnut	L	L	M	L	§	§	§	§	§
Starvation									
Beech	L	L	M	N	N	N	N	N	N
Aspen	N	N	M	L	L	N	N	N	N
Balsam fir	H	L	L	N	N	N	L	N	N
Tamarack	L	N	N	N	L	N	L	N	N
Alder	L	N	N	N	N	N	N	N	N
Red spruce	L	L	L	N	L	N	N	N	N

*Categories recognized: N - none; L - light; M - moderate; H - heavy; E - extreme.
§Not common, no use recognized.
†Under snow, not available.
‡Species not observed on this survey.

tion (as defined by Severinghaus, 1974). Deer tend to eat them in that order.

In the Deer River area many of the preferred species, including white cedar, American yew (*Taxus americana*), staghorn sumac (*Rhus typhina*), basswood and wiid apple, were rare or absent as a result of forest succession and overbrowsing by deer. Browsing pressure was therefore increased on second-choice and readily eaten species, and starvation species were eaten to some extent even in mild winters. In the severe winter of 1970-71 browsing on all preferred species became extreme early in the season, and in milder winters use of the current annual growth on these species was moderate to heavy. Only two second-choice species were common, so much of the browsing pressure fell on three readily eaten species (sugar maple, black cherry and hazelnut (*Corylus* sp.) and starvation species such as beech, aspen and balsam fir. Availability was a major factor in the winters

of 1969-70 and 1970-71. Most of the browse within the reach of deer in the wintering complex was along woodsroads, in scattered openings or under the less dense hardwood stands. In such situations snow accumulates faster on the ground and takes longer to settle than in softwood stands. The paradox is that browse within the normal reach of deer frequently becomes unavailable in winter because the deer refuse to exert the energy necessary to travel through snow above their brisket (20 inches or more for adults; 15 inches for fawns). During the winter of 1970-71, trees up to 4 to 5 inches in diameter were girdled, and tops on several balsam firs, broken off by heavy snow, were eaten back to a diameter of about an inch.

On the Brown Road area observations showed varying degrees of browsing on preferred species. Wild apple and red maple were abundant, white cedar and striped maple were common, and basswood and staghorn sumac were scattered throughout the area. Current growth on sumac was browsed moderately to heavily every winter, while basswood received only light use. Apparently, deer actively sought out sumac, perhaps because it was conspicuous along windrows and hedges. Preferential browsing occurred on white cedar, apple and the maples. Apparently the abundance of these species allowed deer to pick and choose to suit their taste. For example, white cedar was heavily used in the winter of 1970-71; however, in the preceding and succeeding winters only occasional light browsing was observed. The white cedar stands provided cover and easier travelling for deer during periods of stress and thus were attractive for other reasons than food. The tighter concentration of deer for a longer period of time in the winter of 1970-71 was also reflected in heavy browsing on apple trees in the concentration area, although browsing on all other species, except silky dogwood, was light to negligible. The variety of preferred and second-choice species available to deer, combined with well dispersed softwood cover, made this area an ideal wintering situation for deer. Even during the extremely long harsh winter of 1970-71 deer appeared to survive in good physical condition (Jackson, 1974a). It seems likely that at least twice as many (about 40) deer could spend the winter in this area without seriously affecting the range (Jackson, 1974b).

DEER MOVEMENT

All data on the movement of individual deer were derived from the trapping and tagging operations in the Deer River area. These data combined with general observations of deer activity during aerial surveys and ground reconnaissance provided the basis for determining the activity patterns of deer on their fall and winter range. In the three winters, 19 different deer were trapped, tagged and released (Table 7). No deer were captured on the Brown Road area.

During the three winters when trapping was carried on, traps were operated from mid-January to the first week in March, and in 1970-71 it was continued into the first week of April because deer were concentrated

Table 7. Summary of Deer Trapped and Tagged in the Deer River Area and Subsequent Data Concerning Them

Initial capture					Recovery		
Winter	Date	Sex	Age	Retrapped (date)	Date	Cause of death*	Distance from where trapped (miles)
1970-71	January 20	Male	Adult	..	November 27, 1971	Hunting	1.7
	January 21	Male	Adult	..	..	..	..
	January 21	Male	Adult	January 25, 1971			
				January 30, 1971			
				February 2, 1971			
				March 17, 1971			
				March 20, 1971			
				March 26, 1971			
				April 2, 1971			
				April 4, 1971	November 8, 1972	Hunting	2.7
	January 22	Male	Adult	..	December 1, 1973	Hunting	4.5
	January 24	Male	Adult	..	November 4, 1972	Hunting	2.8
	January 30	Male	Fawn	..	October 30, 1971	Hunting	2.5
	January 31	Male	Adult	..	..	..	..
1971-72	February 18	Male	Fawn	February 22, 1972	§	Starved	1.4
	February 21	Female	Adult	..	..	..	..
	February 22	Female	Adult	February 19, 1973	..	..	..
	February 24	Female	Adult	January 31, 1973	..	..	..
	February 24	Female	Adult	..	..	..	..
1972-73	January 17	Female	Fawn	..	..	..	..
	January 17	Male	Fawn	February 18, 1973			
				February 25, 1973			
				March 1, 1973	December 3, 1973	Hunting	1.9
	January 18	Male	Adult	February 2, 1973†	..	..	..
	January 18	Female	Adult	January 31, 1973			
				February 15, 1973	..	..	..
	February 13	Female	Adult	..	..	..	..
	February 19	Male	Fawn	..	..	..	..
	February 22	Male	Adult	March 3, 1973	..	..	..

*Recoveries by hunting were during regular open season.
§Animal found dead on April 16, 1972; probably died during March.
†This animal was retrapped in two different traps on this date.

up to that time. Success was about equally distributed with seven deer being caught in 1970-71, five in 1971-72 and seven in 1972-73. Trapping conditions differed greatly, however, and none of the winters was considered optimum for trapping. During 1970-71, only five traps were in operation, and heavy snow confined or restricted the deer to softwood cover except during the last week of February. Deer activity in the vicinity of the traps was less than in succeeding winters and inclement weather reduced the number of effective trap nights. In 1971-72 and 1972-73 traps were operated throughout the winter except for short periods when certain ones were inactivated due to lack of deer activity in their vicinity. These two winters were much milder, the only period during which deer were restricted or confined to softwood cover being about one week in March 1972. During these milder winters, deer activity was widespread but most deer did not stay in the vicinity of the traps. The trapping records show that a few deer habitually frequented trap sites, but most ranged freely in hardwoods up to 3 miles from either of the areas where the traps were deployed.

Only eight of the 19 trapped deer were retrapped and four of these were retrapped only once. The number of individuals that were retrapped increased each winter. No deer trapped in 1970-71 were retrapped in 1971-72. However, two deer trapped in 1971-72 were retrapped in 1972-73. There was no indication that a particular age or sex group was more likely to be retrapped since each group was retrapped in the same proportion as it had originally been trapped. Adult males were trapped most frequently, and six of the eight were taken in the winter of 1970-71. Two factors may have been responsible: (1) adult males tended to dominate the other deer and entered traps more readily in the first year of trapping, and (2) deep snow in the winter of 1970-71 limited the travel of smaller, weaker deer. Further analysis of these data was not warranted because of the small sample.

Seven of the 19 tagged animals, all males, had been recovered when this paper was written (1975). The male fawn tagged on February 18, 1972 was found the following month 1.4 miles west of where it had been trapped. A rabbit hunter reported the carcass which had been carrionized. When it was examined at the Wildlife Research Laboratory at Delmar (N.Y.), it was concluded that the animal would have succumbed to malnutrition regardless of the actual cause of death. The other six deer, all taken by hunters during the fall open season, were recovered from 1.7 to 4.5 miles (average 2.7) from where they had been tagged and released. These deer travelled generally in a west to northwest direction from the point of release. One exception was a 3 1/2-year-old adult male recovered 4.5 miles south of its point of release. This deer apparently travelled up the Deer River drainage to Dugway Brook (a tributary), while the others moved down the drainage into the Town of Santa Clara. One animal, a 4 1/2 year old, was taken on Long Pond Mountain in the southwestern cor-

ner of the Town of Malone and was the only deer recovered in the Town. The deer recovered ranged in age from less than a year to 5 1/2 years. Tagged deer still at large in the Deer River area included five adult males and seven adult females. It appears unlikely that the females will be recovered.

DISCUSSION

Weather influenced virtually every phase of the study and was a key factor in locating deer wintering areas and documenting deer movement. Winter weather, considered here as that for the months of December through April, influenced: (1) when deer would begin to concentrate on their usual winter range; (2) the extent to which deer would be confined or restricted to certain parts of this range; (3) the extent and type of deer activity at any given time of day; and (4) when deer would return to their summer range. In addition, weather influenced project activities: (1) when aerial surveys could be made; (2) when ground surveys could be made in order to observe deer activity; and (3) when and when not to bait or set traps and when to start and cease deer trapping operations. Ground surveys were not as contingent on weather as were aerial surveys, but certain limits existed. Deer are difficult to locate on a supporting crust with no powder snow and deer activity is slight during storms, so surveys had to be made a day or two following significant snowfalls. Trapping operations were hindered on several occasions by deep snow that limited the movement of both deer and project personnel, by ice that froze trigger mechanisms so they would not work, by snow storms that sprung set traps, and by alternate freezing and thawing temperatures that resulted in frozen trap doors and settling of traps.

It is evident from the data collected that winter deer populations in the Town of Malone differed from summer and fall populations in the Town due to inter-town movement. While it was determined that some deer that wintered in the part of the Deer River area in the Town of Duane had spent the summer and fall in the Town of Malone, it was not determined where those that wintered in the Brown Road area came from. Efforts to trap and mark deer in the Brown Road area, where the majority of the deer in the Town wintered, were unsuccessful. Therefore, little was learned about movement patterns of deer there. Aerial and ground surveys plus sightings by local residents indicated that deer dispersed from this area in all directions in the spring. Trails were observed leading into the Brown Road area from Winslow Brook on the south, Childs Road and Hicks Road on the north and Branch Brook on the west. Winter reconnaissance indicated loose concentrations around the Brown Road area during periods when deer could travel freely.

Movement patterns in the Deer River wintering area are better understood as a result of the trapping and tagging program. Some deer from this area were known to spend the summer and fall in the Town of

Malone in the vicinity of Twin Ponds. Trails leading across Route 30 toward the Titusville Mountains were also noted, but no tagged deer were recovered east of that highway. It would appear that at least some deer from the Deer River area spent the summer and fall in the Titusville Mountains in the southeastern corner of the Town. Other deer from this part of the Town may winter in the Brick Yard-Townline Brook and Studley Hill areas in the Town of Duane. However, deer numbers in those areas were small, i.e., fewer than 10 compared with 100 or more in the Deer River area.

There was no indication where they came from, but a few deer spent the winters of 1972-73 and 1973-74 in the vicinity of Barre Hill north of Malone Village. Prior to these winters deer were not observed north of Route 11, and townspeople reported that deer had not been seen in that area in a number of years. This does not necessarily mean that deer had increased in the Town of Malone, they may simply have been more widely distributed during these extremely mild winters. If any substantial number of deer from the Deer River wintering area spent part of the year in the Town, there could have been a population increase as a result of greater survival during the last three winters. Records for the annual legal take by hunting do not support this hypothesis, however (Jackson, 1974a).

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TOXICITY OF PROPOXUR TO BROOK TROUT AND LANDLOCKED SALMON

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ABSTRACT

Static bioassay tests of propoxur were conducted using brook trout and landlocked salmon fingerlings to produce estimates of acute toxicity. For brook trout, the 24-hour EC_{50} was estimated to be 3.0 milligrams per liter, and the 24-hour LC_{50} was estimated to be 6.0 milligrams per liter. The 24-hour LC_{50} for landlocked salmon was estimated to be 11.2 milligrams per liter. It is considered highly unlikely that normal application rates would produce such concentrations, and direct mortality of these species as a result of such applications would probably not occur.

The New York State Department of Health has been conducting field tests of a commercial formulation of propoxur (2-(1-methylethoxy)phenol methylcarbamate), a carbamate insecticide (Thompson, 1975) to determine its effectiveness in controlling adult mosquitoes that may be disease vectors. This formulation is also being considered for use as an alternative blackfly adulticide in the Adirondacks. Either use might cause contamination of the aquatic habitat through direct application to wetlands or runoff from treated areas. To assess the likelihood that this would result in direct fish mortality, the authors estimated the acute toxicity of propoxur using fingerling brook trout (*Salvelinus fontinalis*) and landlocked salmon (*Salmo salar*). The work was done in 1976.

MATERIALS AND METHODS

Static bioassay procedures as described by Douderoff et al. (1951) were used. The brook trout were obtained from hatchery stock at the Fish Pathology Laboratory at the Rome Fish Hatchery. The mean length of these fish was 39.6 millimeters with a range of 25 to 48 millimeters. The landlocked salmon were hatchery stock being reared at the Adirondack Fish Hatchery. Their mean length was 45.7 millimeters with a range of 32 to 58 millimeters. The bioassays were conducted at the respective hatcheries so that the fish could be tested in water to which they were already acclimated and so that the tests could be run using dilution water having approximately the characteristics of the natural waters in areas that might be treated.

The brook trout test was made between February 25 and March 11 at a water temperature of 10° C., with dissolved oxygen of 10.3 milligrams per liter and a pH of 7.5. The landlocked salmon test was made between July

26 and 28 at a water temperature of 8° C. ± 0.5° C., with dissolved oxygen of about 7.0 milligrams per liter and a pH in the head trough of 6.8. The test containers were round Pyrex jars with a capacity of 20 liters and were filled with either 10 or 16 liters of water for the test. The jars were then immersed in troughs of flowing water to provide a constant-temperature bath. Ten fish were tested in each jar.

Technical propoxur obtained from the Chemagro Division of the Mobay Chemical Corp. was dissolved in acetone to make stock solutions of 10,000 milligrams per liter for the brook trout test and 100,000 milligrams per liter for the landlocked salmon test. Acetone in volume equal to that added in the highest tested concentration was added to the jars containing control fish. Concentrations were selected for testing from the logarithmic series suggested by Douderoff et al. (1951) based on preliminary estimates of toxicity which differed for each species. Most tests were of 24 hours duration, an exposure period longer than the probable duration of exposure in a field application of propoxur. In addition, some of the brook trout were tested for 96 hours to determine whether there was a delayed effect.

The brook trout tests were also used to estimate the concentration which would affect 50 per cent of the test fish during a 24-hour exposure period (24-hour EC_{50}). Preliminary work indicated that some fish were obviously affected early in the test but had apparently recovered at the end of 24 hours. Therefore, a geometric series of observation times (after Sprague, 1973) was used to determine the maximum number of obviously affected fish at any time during the test.

The resulting data from all tests were analyzed according to the nomograph procedures of Litchfield and Wilcoxon (1949).

RESULTS AND DISCUSSION

The results of the bioassay on brook trout are given in Table 1. The percentage affected represents the maximum number either dead or obviously affected (in most cases turned over) at any observation during the 24 hours. Observations were made at 1/4, 1/2, 1, 2, 4, 8 and 24 hours. In most cases the maximum effect had occurred after about 2 hours of exposure. Intermediate exposures (less than 24 hours) were checked only for those concentrations that were considered necessary for defining the toxicity curve for effect. In some cases fish in a given jar were used for more than one test. Therefore, the number of fish upon which the percentage of mortality or effect was based varied as shown in Table 1. No control fish died or were affected at any time.

These data were plotted on log-probit paper (Figures 1 and 2). The 24-hour LC_{50} was found to be 6.0 milligrams per liter with a 95 per cent confidence interval of 4.8 to 7.5 milligrams per liter (all confidence intervals were calculated at the 95 per cent level). The 24-hour EC_{50} was deter-

TABLE 1. RESULTS OF BIOASSAY ON BROOK TROUT DURING 24-HOUR EXPOSURE TO PROPOXUR

Concentration (milligrams per liter)	Mortality		Effect*	
	Per cent	Number§	Per cent	Number§
1.0	0	10	0	10
1.8	10	10	20	10
3.2	30	20	60	10
4.2	45	20	75	20
5.6	43.3	30	70	10
6.5	46.6	30	70	20
7.5	60	20	. .†	. .
8.7	. .‡	. .	100	10
10.0	100	10	100	10
13.5	100	10	100	10
Control	0	40	0	40

*Includes all fish observed to have been affected at any time during test.
§Number tested.
†No intermediate observations made.
‡Test not continued for full 24 hours; terminated when all fish had been affected.

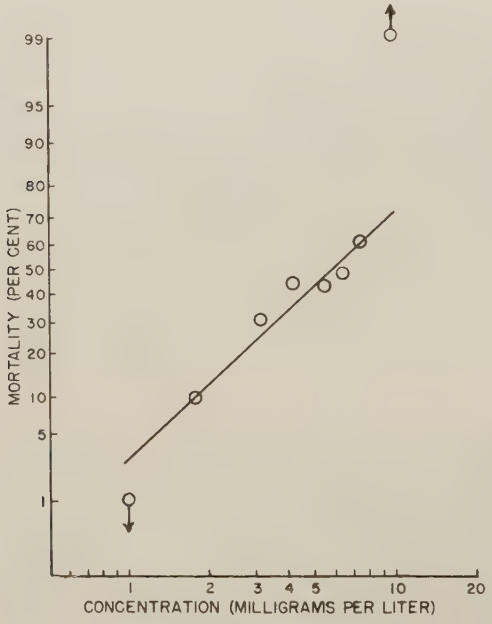

Figure 1. Mortality of brook trout exposed to propoxur for 24 hours.

mined to be 3.0 milligrams per liter with a confidence interval of 2.2 to 4.1 milligrams per liter. The slope functions (i.e., 2.54 with a confidence interval of 1.88 to 3.43, and 2.95 with a confidence interval of 1.73 to 5.02, respectively) were tested for parallelism, and no significant difference was found. The potency ratio, comparing the 24-hour LC_{50} with the 24-hour EC_{50}, was 2.0 with a confidence interval of 1.4 to 3.5. Thus propoxur af-

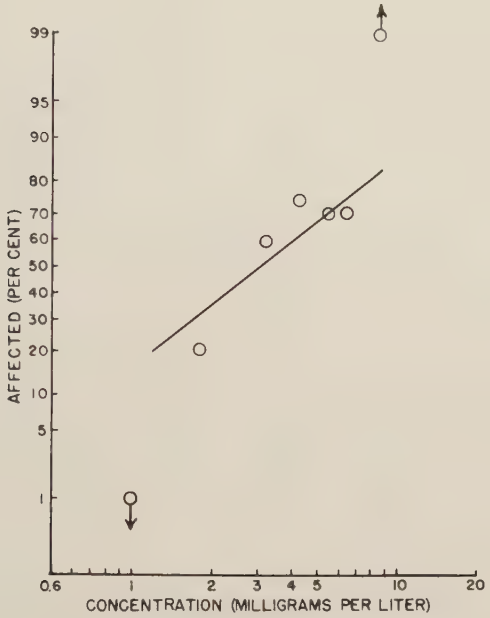

Figure 2. Percentage of brook trout affected during 24-hour exposure to propoxur.

TABLE 2. RESULTS OF BIOASSAY ON LANDLOCKED SALMON DURING 24-HOUR EXPOSURE TO PROPOXUR

Concentration (milligrams per liter)	Number tested	Mortality (per cent)
0.5	20	0
1.0	20	0
3.2	20	0
6.5	20	15
8.7	20	35
10.0	20	35
13.5	20	65
18.0	20	85
49.0	40	95
100.0	20	100
Control	30	0

fected brook trout at about half of the concentrations that were required to kill them during a 24-hour exposure.

The results for landlocked salmon are given in Table 2 and Figure 3. When these data were analyzed by the Litchfield and Wilcoxon method, the 24-hour LC_{50} was computed to be 11.2 milligrams per liter with confidence interval of 9.5 to 13.2 milligrams per liter. The slope function was 1.70 with a confidence interval of 1.53 to 1.89. When the slopes of the fitted lines for the brook trout and landlocked salmon mortality curves were tested for parallelism, a significant ($P < 0.05$) difference was found. This

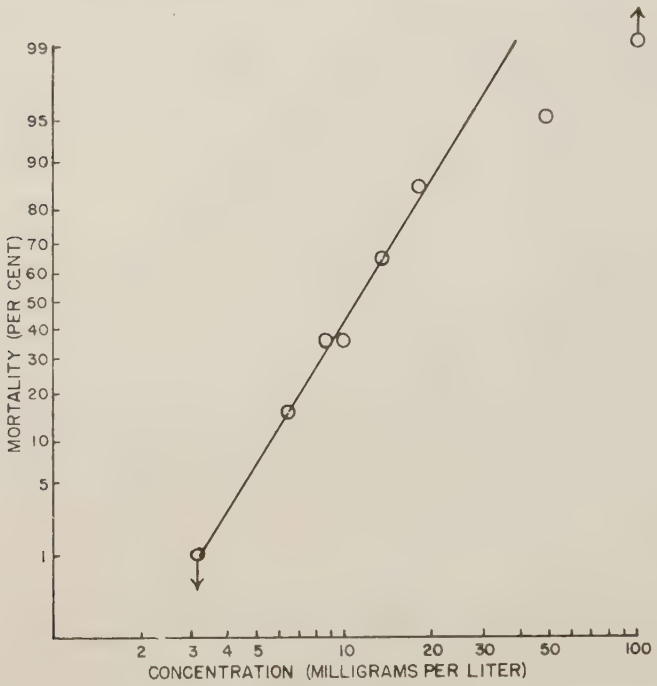

Figure 3. Mortality of landlocked salmon exposed to propoxur for 24 hours.

TABLE 3. ESTIMATED EC_{50} FOR BROOK TROUT EXPOSED TO PROPOXUR FOR VARIOUS PERIODS

Exposure (minutes)	EC_{50} (milligrams per liter)	Confidence interval* (milligrams per liter)
15	21.0	19.5 - 22.7
30	12.9	10.5 - 16.55
45	8.1	5.5 - 11.9
60	5.0	4.1 - 6.2
120	4.2	3.0 - 5.8
240	3.8	3.0 - 4.8
1,440	3.0	2.2 - 4.1

*At 95 per cent level.

may indicate a difference between species response to propoxur, or it may have been due to different characteristics of the test waters. In any case, salmon in the less productive Adirondack water were more tolerant, although the range of concentrations between 0 and 100 per cent mortality for brook trout in the Rome water was greater.

To determine whether there might be a delayed effect in the case of exposure to a concentration slightly lower than that observed to cause an effect in 24 hours, 10 brook trout were exposed to 1 milligram per liter for 96

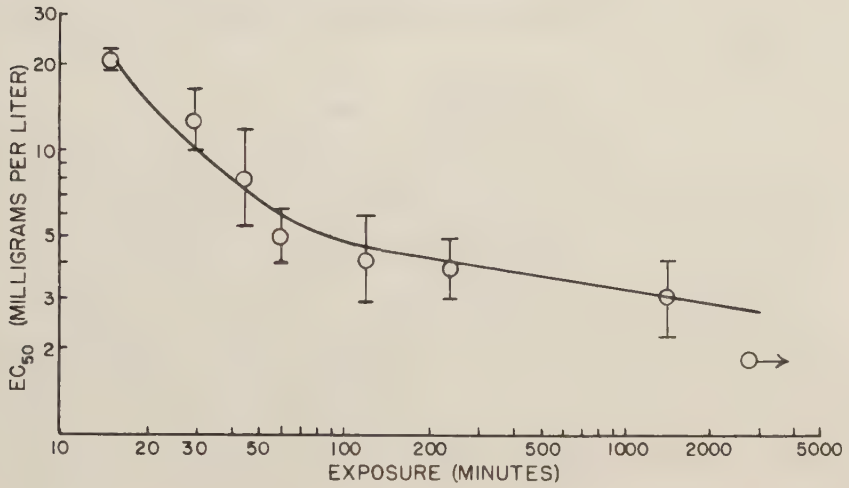

Figure 4. Toxicity of propoxur to brook trout in relation to length of exposure. Vertical bars represent 95 per cent confidence interval.

hours in a static test. No fish were observed to be affected during this period.

The EC_{50} for brook trout was determined for six exposure times other than 24 hours. In order to better define the toxicity, it was considered necessary to determine a 45-minute EC_{50}, but one for 8 hours was not considered useful. Confidence limits for these values were determined by the methods of Litchfield and Wilcoxon (1949). These are summarized in Table 3 which is the basis for Figure 4, a toxicity curve relating time of exposure to its corresponding EC_{50}.

CONCLUSIONS

Propoxur has been used at rates of 1 to 2 ounces active ingredient per acre in the field tests by the State Department of Health. As it is normally applied for controlling adult biting flies, all but the smallest streams, which are obscured by the forest canopy, are avoided. Since it is applied to the treated portion of a watershed in a virtually simultaneous aerial operation, fish populations may be subjected to a short-term exposure. If the material were applied directly to the stream at these rates, the theoretical concentration in a stream 0.1 meter deep would range from 0.07 to 0.14 milligram per liter. Concentrations in deeper streams would be proportionally less.

Data for acute toxicity indicate that it is unlikely that exposure to these concentrations for less than 24 hours would cause mortality or have a noticeable gross effect on brook trout or landlocked salmon. This does not, however, eliminate the possibility that subtle effects on behavior, stamina, growth, reproduction or discrimination of environmental stimuli may oc-

cur. Further research is needed to determine whether these subtle effects are indeed occurring.

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TOXICANTS IN SNAPPING TURTLES[1]

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ABSTRACT

Selected tissues from 32 snapping turtles from New York waters were analyzed for organochlorine contaminants. High levels of organochlorines, especially PCB's, were found in the fat (e.g., a mean of 2,990.60 ppm for the specimens from the Hudson River). Snapping turtles from the Hudson River and some other localities in the State seem unsuitable for human consumption because of contamination of their tissues with persistent pollutants. It is suggested that the snapping turtle would make a useful addition to the species used for monitoring, and finding, cumulative toxicants.

The snapping turtle (*Chelydra serpentina*) is a common, large, omnivorous, aggressive, freshwater chelonian that has a wide distribution in the eastern United States (Carr, 1952; Ernst and Barbour, 1972). Since snapping turtles are relatively sedentary (Hammer, 1969) and long-lived, it was hypothesized that they would be an excellent species for monitoring pollutants in aquatic ecosystems. In addition, since their skeletal muscle, liver and eggs are used for human food (Rombauer and Becker, 1931; Seagears, 1949; Angier, 1970; Herity, 1978), it appeared important to examine selected tissues (especially from specimens from the heavily PCB-polluted Hudson River) for levels of organochlorine contaminants.

MATERIALS AND METHODS

Thirty-two snapping turtles were captured from various waters in New York (23 from the Hudson River and nine from other localities) and submitted to the Wildlife Pathology Unit of the State Department of Environmental Conservation. The turtles were weighed and then killed by freezing or decapitation, after which the plastron was removed. Notes were made on the general condition of the carcass and the distribution of body fat. Samples of selected tissues (fat, liver, skeletal muscle and eggs) were placed in chemically clean containers, frozen and sent in that condition to Raltech Scientific Services, Inc. at Madison (Wis.) or to the Department's Pollution Laboratory at Rome (N.Y.) where the levels of several organochlorine compounds were determined by gas chromatography (U.S. Food and Drug Administration, 1968; Heath and Hill, 1974), and cad-

[1]The authors acknowledge the assistance of Dr. James Powers in statistical analysis and David Seymour in obtaining turtles from the Hudson River.

mium and mercury concentrations by atomic absorption spectrophotometry. The analyses of fat samples were made on a fat basis; all other data represent wet weight.

In addition to the tissues themselves, turtle soup was made from two specimens. One was a turtle taken July 20, 1978 from the Hudson River 8 miles below Ford Edward, and the other was one taken July 31, 1978 from White Creek in Washington County. Both had high concentrations of PCB's in their fat. Liver and skeletal muscle were used primarily, and for the turtle from White Creek a special effort was made to dissect out as much of the fat as possible from the muscle tissue. The soups were prepared according to the recipe of Seagears (1949).

Because of the relatively small samples and apparent differences in variability for the several tissues examined, *F* tests were first performed for appropriate comparisons, and then the *t* test (Steele and Torrie, 1960, p. 81) was used to compare differences between the resultant mean values.

RESULTS

The tissues examined comprised fat samples from 20 turtles, liver samples from 31 specimens, skeletal muscle samples from 29 specimens and eggs from six specimens. The levels of polychlorinated biphenyls (PCB's), the DDT metabolite DDE, and the insecticide Dieldrin in these tissues are summarized in Tables 1 to 4. All samples[2] had detectable levels of PCB's, the highest being in the fat of turtles from the Hudson River (mean = 2,990.60 ppm), while concentrations in the fat of nine specimens from other localities averaged 464.16 ppm. Ten (58.8 per cent) of the 17 fat samples that were tested for Dieldrin had high concentrations (> 0.3 ppm), and five (31.2 per cent) of the 16 tested for DDE had concentrations greater than 5 ppm. A male turtle from Irondequoit Bay on Lake Ontario that weighed 16.4 kilograms had residue levels (ppm) in its fat as follows: PCB's, 666.0; DDE, 81.3; Dieldrin, 34.1; hexachlorobenzene, 0.94; heptachlor epoxide, 19.7; and Mirex, 19.7.

Concentrations of PCB's in 22 liver samples from turtles from the Hudson River averaged 66.05 ppm, and eight livers from turtles from other waters had a mean of 7.77 ppm. Concentrations of DDE and Dieldrin were generally low in the livers, but there were occasional exceptions (Table 2). The liver of the male turtle from Irondequoit Bay already mentioned had residue levels (ppm) as follows: PCB's, 27.8; DDE, 3.58; Dieldrin, 0.99; hexachlorobenzene, 0.24; heptachlor epoxide, 0.85; Mirex, 0.81; and mercury, 2.72.

In contrast, skeletal muscle from 22 samples from turtles from the Hudson River averaged 4.24 ppm for PCB's with five of them (22.7 per cent)

[2]The samples examined totalled 83 because the tissues (except eggs) for two turtles from the Hudson River were pooled.

TABLE 1. TOXICANTS IN SAMPLES OF FAT TISSUE FROM SNAPPING TURTLES FROM VARIOUS LOCALITIES IN NEW YORK

Locality	Date	Sex	Gross weight (kilograms)	Toxicant*		
				PCB's	DDE	Dieldrin
	Hudson River					
North Bay (near Tivoli)	June 14, 1976	Female	4.2	306	< 5.00	< 0.20
North Bay (near Tivoli)	June 14, 1976	Male	2.0	§	§	§
Constitution Island Marsh	May 19, 1977	Male	4.6	4,319	57.50	8.80
Piermont Marsh	May 26, 1977	Male	1.5	628	n.d.	1.50
North Bay (near Tivoli)	June 13, 1977	Male	10.2	1,698	n.d.	0.50
Vanderburgh Cove (near Staatsburg)	June 13, 1977	Male	15.4	7,990	n.d.	26.50
Vanderburgh Cove (near Staatsburg)	June 15, 1977	Male	13.6	5,412	n.d.	12.80
Suckley Cove (near Staatsburg)	June 21, 1977	Female	3.5	1,123	. .	17.00
North Bay (near Hudson)	June 22, 1977	Male	4.8	330	15.30	0.33
8 miles below Fort Edward	July 20, 1978	Male	9.1	7,258	. .	. .
8 miles below Fort Edward	July 20, 1978	Male	2.7	842	. .	. .
Mean			6.51	2,990.60	<11.11	< 8.45
	Other waters					
Otselic River (near Cincinnatus)	May 2, 1977	Female	2.3	99.9	0.14	n.d.
Spring Lakes (Dutchess Co.)	June 23, 1977	Female	2.9	44.4	1.4	n.d.
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.9	335	3.40	1.60
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.7	410	8.40	2.40
St. Lawrence River (near Morristown)	June 12, 1978	Female	2.4	310	8.80	n.d.
White Creek (Washington Co.)	July 31, 1978	Male	3.4	2,281	n.d.	n.d.
Black Creek Marsh (near Guilderland, Albany Co.)	September 13, 1978	Male	9.1	30.8	0.06	0.06
Black Creek Marsh (near Guilderland, Albany Co.)	September 13, 1978	Male	8.2	0.36	0.02	n.d.
Irondequoit Bay (Lake Ontario)	September 20, 1978	Male	16.4	666	81.30	34.10
Mean			5.59	464.16	11.50	4.24

*Data in ppm on fat basis; n.d. indicates substance tested for but not detectable.
§Tissue samples from this specimen pooled with those from preceding specimen.

Table 2. Toxicants in Samples of Liver Tissue From Snapping Turtles From Various Localities in New York

Locality	Date	Sex	Gross weight (kilograms)	Toxicant*		
				PCB's	DDE	Dieldrin
Hudson River						
North Bay (near Tivoli)	June 14, 1976	Female	4.2	10.60	0.05	0.017
North Bay (near Tivoli)	June 14, 1976	Male	2.0	§	§	§
Constitution Island Marsh	June 15, 1976	Female	3.8	6.95	0.91	n.d.
Constitution Island Marsh	June 15, 1976	Female	4.6	11.50	<0.05	0.026
Constitution Island Marsh	May 19, 1977	Male	8.6	45.80	0.63	0.16
Constitution Island Marsh	May 19, 1977	Male	1.0	9.42	. .	. .
Piermont Marsh	May 26, 1977	Male	1.5	1.79	0.09	. .
Piermont Marsh	May 26, 1977	Female	3.8	3.13	0.05	0.017
North Bay (near Tivoli)	June 13, 1977	Male	10.2	0.54	n.d.	0.038
Vanderburgh Cove (near Staatsburg)	June 13, 1977	Male	15.4	103.00	. .	. .
North Bay (near Tivoli)	June 14, 1977	Female	3.9	21.32	0.33	. .
Kingston Point	June 15, 1977	Female	9.1	107.00	. .	. .
Kingston Point	June 15, 1977	Female	5.4	73.90	. .	. .
Vanderburgh Cove (near Staatsburg)	June 15, 1977	Male	13.6	174.00	. .	. .
Iona Island Marsh	June 20, 1977	Male	5.3	91.71	2.11	. .
Iona Island Marsh	June 20, 1977	Male	0.4	4.65	0.01	. .
Iona Island Marsh	June 20, 1977	Male	2.2	1.79	0.04	. .
Iona Island Marsh	June 20, 1977	Male	0.9	2.00	0.01	. .
Suckley Cove (near Staatsburg)	June 21, 1977	Female	3.5	45.42	0.99	. .
North Bay (near Hudson)	June 22, 1977	Male	4.8	2.50	0.17	. .
8 miles below Fort Edward	July 20, 1978	Male	9.1	683.00	17.40	0.086
8 miles below Fort Edward	July 20, 1978	Male	2.7	9.21	n.d.	n.d.
8 miles below Fort Edward	July 31, 1978	Male	2.7	21.80	0.71	n.d.
Mean			5.16	66.05	<1.39	0.038

Other waters						
Spring Lakes (Dutchess Co.)	June 23, 1977	Female	2.9	0.48	. .	. .
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.9	3.30	0.038	0.03
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.7	7.40	0.049	0.07
St. Lawrence River (near Morristown)	June 12, 1978	Female	2.4	21.40	0.77	0.08
White Creek (Washington Co.)	July 31, 1978	Male	3.4	1.39	0.01	n.d.
Black Creek Marsh (near Guilderland, Albany Co.)	September 13, 1978	Male	9.1	0.20	n.d.	n.d.
Black Creek Marsh (near Guilderland, Albany Co.)	September 13, 1978	Male	8.2	0.10	n.d.	n.d.
Irondequoit Bay (Lake Ontario)	September 20, 1978	Male	16.4	27.80	3.58	0.99
Mean			6.0	7.77	0.64	0.17

*Data in ppm on wet weight basis; n.d. indicates substance was tested for but not detectable.
§Tissue samples from this specimen pooled with those from preceding specimen.

TABLE 3. TOXICANTS IN SAMPLES OF SKELETAL MUSCLE TISSUE FROM SNAPPING TURTLES FROM VARIOUS LOCALITIES IN NEW YORK

Locality	Date	Sex	Gross weight (kilograms)	Toxicant*		
				PCB's	DDE	Dieldrin
Hudson River						
North Bay (near Tivoli)	June 14, 1976	Female	4.2	11.40	< 0.5	0.019
North Bay (near Tivoli)	June 14, 1976	Male	2.0	§	§	§
Constitution Island Marsh	June 15, 1976	Female	3.8	0.67	0.015	. .
Constitution Island Marsh	June 15, 1976	Female	4.6	1.63	< 0.05	n.d.
Constitution Island Marsh	May 19, 1977	Male	8.6	3.45	n.d.	0.01
Constitution Island Marsh	May 19, 1977	Male	1.0	0.31	n.d.	n.d.
Piermont Marsh	May 26, 1977	Male	1.5	0.20	0.01	. .
Piermont Marsh	May 26, 1977	Female	3.8	0.47	0.01	n.d.
North Bay (near Tivoli)	June 13, 1977	Male	10.2	1.67	n.d.	0.01
Vanderburgh Cove (near Staatsburg)	June 13, 1977	Male	15.4	15.70	. .	. .
North Bay (near Tivoli)	June 14, 1977	Female	3.9	0.69	0.01	. .
Kingston Point	June 15, 1977	Male	9.1	1.83	. .	. .
Kingston Point	June 15, 1977	Female	5.4	1.02	. .	. .
Vanderburgh Cove (near Staatssburg)	June 15, 1977	Male	13.6	6.27	. .	. .
Iona Island Marsh	June 20, 1977	Male	5.3	2.07	0.05	. .
Iona Island Marsh	June 20, 1977	Male	0.4	0.52	n.d.	. .
Iona Island Marsh	June 20, 1977	Male	2.2	0.19	n.d.	. .
Iona Island Marsh	June 20, 1977	Male	0.9	0.26	< 0.01	. .
Suckley Cove (near Staatsburg)	June 21, 1977	Female	3.5	27.62	0.74	. .
North Bay (near Hudson)	June 22, 1977	Male	4.8	0.28	< 0.01	. .
8 miles below Ford Edward	July 20, 1978	Male	9.1	11.40	0.26	n.d.
8 miles below Fort Edward	July 20, 1978	Male	2.7	3.03	n.d.	0.034
8 miles below Fort Edward	July 31, 1978	Male	2.7	2.50	n.d.	n.d.
Mean			5.16	4.24	0.093	0.008

Other waters						
Spring Lakes (Dutchess Co.)	June 23, 1977	Female	2.9	0.28	. .	. .
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.9	0.39	< 0.010	0.01
Black Pond (near Ellisburg, Jefferson Co.)	June 12, 1978	Female	2.7	0.81	0.025	< 0.01
St. Lawrence River (near Morristown)	June 12, 1978	Female	2.4	0.34	0.013	< 0.01
White Creek (Washington Co.)	July 31, 1978	Male	3.4	0.48	0.042	n.d.
Irondequoit Bay (Lake Ontario)	September 20, 1978	Male	16.4	0.36	0.023	0.16
Mean			5.12	0.44	<0.023	< 0.038

*Data in ppm on wet weight basis; n.d. indicates substance was tested for but not detectable.
§Tissue samples from this specimen pooled with those from preceding specimen.

Table 4. Toxicants in Eggs of Snapping Turtles From the Hudson River

Locality	Date	Gross weight* (kilograms)	Toxicant§		
			PCB's	DDE	Dieldrin
North Bay (near Tivoli)	June 14, 1976	4.2	17.9	< 0.05	0.022
Constitution Island Marsh	June 15, 1976	3.8	42.9	< 0.05	0.049
Constitution Island Marsh	June 15, 1976	4.6	15.7	0.56	< 0.050
Piermont Marsh	May 26, 1977	3.8	10.4	0.055	0.018
North Bay (near Tivoli)	June 14, 1977	3.9	20.8	. .	0.013
Suckley Cove (near Staatsburg)	June 21, 1977	3.5	32.7	. .	0.055
Mean		3.97	28 9	< 0.18	< 0.035

*Of parent female.
§Data in ppm.

exceeding 5 ppm. Such tissues from six turtles from other localities averaged 0.44 ppm. The levels of DDE and Dieldrin in skeletal muscle were all quite low.

All six egg samples were from turtles from the Hudson River and had considerable concentrations (> 5.0 ppm) of PCB's (mean = 28.9 ppm). Levels of DDE and Dieldrin were low.

Tests for statistical differences between turtles from the Hudson River and those from other localities, with respect to mean concentrations of PCB's in the fat, liver and skeletal muscle, are summarized in Tables 5 and 6. Both the F and t' tests indicated that there were significant differences, for the tissues analyzed, between the two areas.

The soup made from the turtle from the Hudson River yielded 230 ppm of PCB's, while that from the one from White Creek yielded 0.091 ppm. A single bowl of the former (250 milliliters = 270 grams) would contain a dose of 62.1 milligrams of PCB's. The tissues analyzed for the turtle from the Hudson River showed PCB levels of 7,258 in its fat, 683 ppm in its liver and 11.4 ppm in its skeletal muscle. The corresponding values for the other turtle were 2,281, 1.4 and 0.5 ppm, respectively. Despite the fact that the turtle from White Creek had lower amounts of PCB's in its tissues than the one from the Hudson River, removing the fat from the portions used in preparing the soup apparently was effective in reducing the relative amount in it to a much greater degree.

TABLE 5. RESULTS OF F TESTS OF THE VARIANCE OF PCB CONCENTRATIONS IN TISSUES OF SNAPPING TURTLES FROM THE HUDSON RIVER VS. OTHER LOCALITIES IN NEW YORK

Tissue	Locality	Number	Sum of squares	Value of F
Fat	Hudson River	10	8,941,722.49	
	Other	9	512,102.88	17.46*
Liver	Hudson River	22	21,200.77	
	Other	8	116.52	181.95*
Skeletal muscle	Hudson River	22	45.58	
	Other	6	0.04	1,139.45*

*Significant at $P = < 0.001$.

TABLE 6. RESULTS OF t' TESTS OF DIFFERENCES BETWEEN MEAN VALUES FOR PCB CONCENTRATIONS IN TISSUES OF SNAPPING TURTLES FROM THE HUDSON RIVER VS. OTHER LOCALITIES IN NEW YORK

Tissue	Value of t'	
	Critical	Calculated
Fat	2.26	2.59*
Liver	1.73	1.83*
Skeletal muscle	1.73	2.64*

*Significant at $P < 0.05$.

The two snapping turtles whose tissue samples were pooled were both taken on June 14, 1976 from North Bay at Tivoli on the Hudson River. The pooled sample of liver and that of skeletal muscle each had less than 0.06 ppm of cadmium. However, for four turtles from the Hudson River at Constitution Island Marsh, two taken on June 15, 1976 and two on May 19, 1977, the mean and range of cadmium concentrations were 16.99 (8.58-26.20) ppm in the liver and 0.77 (0.12 - 1.41) ppm in the skeletal muscle. Turtles seem to be able to tolerate large concentrations of cadmium (Robinson and Wells, 1975), but further research is needed.

DISCUSSION

These data demonstrate that the fat, liver and eggs (tissues that usually contain higher lipid levels than other tissues) of snapping turtles contain greater concentrations of organochlorine toxicants than does skeletal muscle. They also indicate that turtles from the Hudson River contain significantly higher levels of PCB's than turtles from the other localities from which specimens were obtained. In addition to toxicants received through diet, the snapping turtle may acquire hydrophobic compounds, such as PCB's, through its mucous membranes during aquatic pharyngeal and cloacal respiration (Hammer, 1969).

The U.S. Food and Drug Administration has recognized no specific tolerances or action levels for deleterious substances in snapping turtles. However, the agency's sanctioned levels for human consumption of the edible portion of fish are as follows: PCB's, 5.0; DDE, 5.0; Dieldrin, 0.3; heptachlor epoxide, 0.3; Mirex, 0.1; and mercury, 1.0 (U.S. Food and Drug Administration, 1978).

In light of the findings of the present study, snapping turtles from the Hudson River, below Hudson Falls-Fort Edward, appear unsafe for human consumption. Although the skeletal muscle was generally low in organochlorine residues, leaving a small amount of fat on the meat could result in elevated contaminant levels in soups and stews. In recipes that also use the liver and/or eggs, the risk of high levels of contaminants is even greater. More data are needed for snapping turtles from Lake Ontario and other areas (e.g., Lake Erie, Onondaga Lake and Lake Champlain), but the data for the specimens from Irondequoit Bay suggest that turtles from Lake Ontario may also be unfit for human consumption. Snapping turtles taken anywhere should be prepared carefully and even small amounts of fat as well as the liver rejected as human food.

Little research has been done on pesticides and industrial pollutants in reptiles. Snakes have been proposed as pollution-indicator species (Bauerle et al., 1975), and alarmingly high levels of some organochlorine toxicants were found in the body fat of a small sample of indigo snakes (*Drymarchon corais*) from Georgia (Lawler, 1977). However, the concentrations of

organochlorines reported in these snakes were lower than those found in snapping turtles during the present study in New York.

The adipose tissue may accumulate organochlorine toxicants throughout the life of a turtle. In order to monitor trends in the degree of pollutant contamination, the concentrations of specific toxic substances can be compared according to age for turtles from selected bodies of water. Age can be estimated from counts of scute annuli (small turtles), from carapace length and, perhaps, by microscopically counting the ring-like formations in sections of the long bones of larger turtles (Gibbons, 1968; Hammer, 1960). Since snapping turtles hold high concentrations of lipid-soluble contaminants in their fat bodies, these organs should be ideal for GC/mass spectrophotometry analysis for a variety of compounds (e.g., dioxin, dibenzofuran and polynuclear aromatic hydrocarbons).

Snapping turtles appeared to be abundant, at least locally, in the Hudson River (e.g., North Bay at Tivoli, Vanderburgh Cove), so chemical pollutants had not noticeably reduced populations in those areas. However, research is needed concerning the impact of organochlorines and other pollutants on the health and behavior of snapping turtles and the hatchability of their eggs.

In addition, the snapping turtle should prove a useful laboratory animal for toxicology studies. Large fat bodies (Pond, 1978) are found on the ventral side of these turtles and extend from the vicinity of the medial aspect of the hind limbs to, in obese individuals, the area of the heart. Also, there are discrete fat deposits in the axial, pericardial, and lateral and ventral neck regions. These adipose tissues can be quickly and easily collected for laboratory chemical analyses.

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COMPARATIVE CHARACTERISTICS OF SURF FISHERMEN AND BOAT FISHERMEN ON LONG ISLAND, NEW YORK[1]

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ABSTRACT

Patricipation in sport fishing and over-all satisfaction with the angling experience depends on several interacting environmental, economic and psycho-social factors. Surveys of surf fishermen and boat fishermen on Long Island (N.Y.) provided data on the characteristics of these fishermen and on several associated variables relating to their attitudes, interests and behavior. In many basic ways, the two groups are similar in their fishing habits and expectations, but there are enough important differences to warrant considering them as distinct groups with separate needs for enjoying their sport. The findings should be useful to those responsible for natural-resource administration, as well as have value for commercial sport-fishing industries in the area.

Research related to the characteristics and behavior of sport fishermen tends to support two general conclusions: (1) sport fishing is more than just a matter of catching fish, and the ultimate success of the angling experience depends on a number of interacting psycho-social and environmental factors; (2) sport fishermen are not a wholly homogeneous group, but may be separated according to demographic traits, species of fish sought and angling methods used. Fisheries management in the coastal zone and the successful operation of commercial sport fishing enterprises depend on both the availability of suitable fish populations and recognition of the characteristics and preferences of the fishermen. Two surveys of salt-water fishermen on Long Island (N.Y.) were conducted in 1975. One was directed at surf fishermen and the other at fishermen using commercial party boats and charter boats. While each had certain specific goals, three primary objectives were common to both:

1. To develop demographic profiles of the surf fishermen and boat fishermen

2. To evaluate the attitudes and opinions of these fishermen toward selected planning and management issues

3. To examine certain psycho-social and environmental factors that contribute to or detract from the sport fishing experience

The parallel development of study methods and survey questionnaires

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allows a direct comparison between these two groups of fishermen with respect to several related variables.[2]

METHODS

Surveys of surf fishermen were made at four locations: Jones Beach, Robert Moses State Park, Smith Point County Park and Montauk State Park. Those of party boat and charter boat fishermen were made at three locations: Montauk Harbor, Captree State Park and the harbor at Sheepshead Bay. These sites were chosen as the most popular in each case based on the work of Briggs (1962, 1965) and Ryan (1972). Data were collected on randomly selected Fridays, Saturdays and Sundays: from July through October for surf fishermen; from September through November for the boat fishermen. In both cases, an attempt was made to contact all fishermen 16 years old or older who were at the site on the data-collection days. Each was given a questionnaire and asked to complete it and return it; questionnaires were collected in person at the end of each fishing day or boat trip. Of 580 questionnaires distributed to surf fishermen, 350 were returned and 263 were suitable for analysis. The corresponding figures for boat fishermen were 825, 536 and 413. The distribution of the usable responses, in terms of the fishing locations surveyed, is shown in Table 1.

Table 1. Distribution of Respondents According to Fishing Location

Location	Respondents	
	Number	Per cent
Surf fishermen		
Jones Beach	64	24.3
Robert Moses State Park	31	11.8
Smith Point County Park	63	24.0
Montauk State Park	105	39.9
Total	263	100.0
Party-boat and charter-boat fishermen		
Montauk Harbor	201	48.8
Captree State Park	108	26.2
Sheepshead Bay	104	25.0
Total	413	100.0

Although the questionnaires for the two groups were different, they related generally to the three primary objectives of the study. The results for items common to both groups are reported and compared in this paper.[3]

[2]Full accounts of the two surveys were reported by Carls (1978) and Carls and Bresnan (1979).

[3]In the tables, where the number of responses total less than 263 for surf fishermen or 413 for boat fishermen, the difference represents returns in which the particular item of information could not be used. It is felt that percentages based on the usable data in each case are the most meaningful.

DEMOGRAPHIC CHARACTERISTICS

Both the surf fishermen and boat fishermen were asked to give certain personal information about themslves, i.e., age, sex, place of residence, occupation and income.

AGE

The data indicated neither surf fishing nor boat fishing to be an age-specific activity (Table 2). For each age group, the proportions for the two

TABLE 2. DISTRIBUTION OF RESPONDENTS ACCORDING TO AGE

Age	Surf fishermen		Boat fishermen	
	Number	Per cent	Number	Per cent
16 - 19	8	3.0	28	7.5
20 - 29	72	27.4	127	33.9
30 - 39	69	26.3	85	22.6
40 - 49	61	23.1	73	19.3
50 - 59	37	14.1	53	14.0
60 - 69	15	5.7	6	1.7
70 and over	1	0.4	2	0.5
Total	263	100.0	337	100.0

samples were relatively similar. The average surf fisherman was 38.5 years old, while the average boat fisherman was somewhat younger, i.e., 35 years old. In general, the fishermen surveyed seemed to reflect the age characteristics of the larger Long Island and New York City populations from which they predominantly came. The median ages for surf fishermen (36.5) and boat fishermen (32.3) compared with values of 30.9 for Suffolk County, 26.3 for Nassau County and 32.4 for New York City in 1970 as given by the U.S. Bureau of Census (1970). The somewhat higher ages of the respondents reflect the omission of fishermen 16 years old or younger from the study samples.

SEX

In the surf fishing sample 94.7 per cent were men, and 90.3 per cent of the boat fishing sample were men. These proportions indicate that both activities were predominantly male-oriented.

PLACE OF RESIDENCE

The distribution of the respondents according to their place of residence is shown in Table 3. Suffolk and Nassau Counties comprise most of Long Island, and New York City (including Brooklyn which is on the western end of the Island) is immediately adjacent. Of the respondents who furnished usable data, 90 per cent or more came from these localities. No par-

TABLE 3. DISTRIBUTION OF RESPONDENTS ACCORDING TO PLACE OF RESIDENCE

Residence	Surf fishermen		Boat fishermen	
	Number	Per cent	Number	Per cent
Suffolk County	110	43.0	106	31.4
Nassau County	84	32.8	51	15.1
New York City	47	18.3	147	43.5
Upstate New York	3	1.2	16	4.7
Out of state	12	4.7	18	5.3
Total	256	100.0	338	100.0

ticular significance is attached to differences between surf fishermen and boat fishermen other than that they probably reflect differences in regional opportunities. For example, the southern shore of the Island in Suffolk County, including Montauk Point, is especially suited for surf fishing which attracts many local residents, whereas the extensive party boat and charter boat operations in Brooklyn's Sheepshead Bay would tend to draw heavily from New York City.

OCCUPATION

The occupations reported by the respondents are summarized in Table 4 according to the standard list used by the U.S. Bureau of Census, together with the proportions of the general population in Suffolk County, Nassau County and New York City engaged in these occupations in 1970 as given by the U.S. Bureau of Census (1970). The data for boat fishermen show no consistent differences in occupation when compared with the census data

TABLE 4. DISTRIBUTION OF RESPONDENTS ACCORDING TO OCCUPATION TOGETHER WITH THAT OF GENERAL POPULATION IN THE VICINITY*

Occupation	Responding fishermen*		General population§		
	Surf	Boat	Suffolk County	Nassau County	New York City
Professional, technical and kindred workers	29.2 (70)	17.7 (50)	18.4	15.1	15.7
Managers and administrators	9.6 (23)	8.2 (23)	9.6	10.5	7.8
Sales workers	12.5 (30)	12.0 (34)	8.3	8.6	7.3
Clerical and kindred workers	0.0 (0)	11.3 (32)	17.4	17.5	27.1
Craftsmen and kindred workers	8.7 (21)	16.7 (47)	15.6	9.7	10.2
Operatives (except transport)	0.8 (2)	5.7 (16)	8.9	5.0	11.0
Transport equipment operators	5.0 (12)	9.2 (26)	3.9	22.6	3.9
Laborers (except farm)	22.5 (54)	6.4 (18)	4.0	5.2	3.3
Farmers and farm managers	0.8 (2)	0.7 (2)	0.3	†	†
Farm laborers and foremen	6.3 (15)	0.0 (0)	0.3	†	†
Service workers (except private household)	1.7 (4)	8.2 (23)	0.3	†	†
Private household workers	2.9 (7)	3.9 (11)	0.7	1.0	1.3
Total	100.0 (282)	100.0 (240)	87.7	95.2	87.6

*Figures in per cent; those in parentheses represent number of records in each case.
§Data from U.S. Bureau of Census (1970); figures in per cent, but total less than 100.0 because only data for corresponding occupations used.
†Less than 0.01 per cent.

for the general population in the vicinity. However, those for surf fishermen show several differences when compared with boat fishermen and other Long Island / New York City residents. First, there were no surf fishermen in the "clerical and kindred workers" category. These jobs are normally associated with women, and this finding reflects the low proportion of women among the surf fishermen sampled. To a somewhat lesser degree this difference was true for the boat fishermen, of whom only 11.2 per cent were clerical workers. Other notable differences with respect to the surf fishermen were the disproportionally high percentages in the categories "professional, technical and kindred workers" and "laborers (except farm)". These findings are more difficult to interpret with the data on hand. To some extent they may reflect the suburban characteristics of much of the region and the lifestyles of the professional and technical people living there. The results may also indicate other more general cultural associations related to group preferences for leisure activities.

INCOME

Generally, the types of fishing studied did not seem to be income-oriented. The difference between the average income of the responding surf fishermen ($18,300) and the boat fishermen ($14,800) is not considered to indicate a cause and effect relationship. Most of the surf fishermen came from Suffolk and Nassau Counties where average incomes tended to be higher than in New York City where about half the boat fishermen resided. The income levels for both groups of fishermen were higher than the averages for the general population, i.e., $13,400 for Suffolk County, $17,600 for Nassau County and $11,600 for New York City in 1970, as given by the U.S. Bureau of Census (1970). However, it seems likely that the difference was chiefly associated with rising income and inflation levels between the census year of 1970 and 1975 when the survey data were collected.

FISHING BEHAVIOR

Three questionnaire items relating to fishing behavior were common to the surf fisherman and boat fisherman studies: (1) years of participation in either type of fishing; (2) frequency of participation during the fishing season; and (3) duration of fishing trips.

YEARS OF PARTICIPATION

Among both groups of fishermen, participants ranged from beginners with no previous experience to those who had fished for more than 50 years. In both cases, however, the average angler was relatively new to the sport. The data are summarized in Table 5. The largest proportion of the surf fishermen (40.7 per cent) and boat fishermen (57.9 per cent) had par-

Table 5. Distribution of Respondents According to Years of Participation

Years	Surf fishermen		Boat fishermen	
	Number	Per cent	Number	Per cent
0 - 5	107	40.7	227	57.9
6 - 10	52	19.8	93	23.7
11 - 15	30	11.4	33	8.5
16 - 20	38	14.4	17	4.4
21 - 25	13	4.9	5	1.3
26 - 30	8	3.0	9	2.3
31 - 35	6	2.3	2	0.6
36 - 40	4	1.5	3	0.8
41 - 45	2	0.8	2	0.5
46 - 50	2	0.8	1	0.3
50 or more	1	0.4	0	0.0
Total	263	100.0	392	100.0

Table 6. Years of Participation Reported by Long Island Respondents Compared With Fishermen Surveyed in Three Other Studies

Study	Average years of participation
Long Island respondents	
Surf fishermen	11.5
Boat fishermen	7.2
Other studies	
Six northeastern states*	26.0
Freshwater fishermen in New York§	24.0
Shark fishermen in Texas †	19.0

*Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont (Bevins et al., 1968).
§From Moeller and Engelken (1972).
†From Graefe and Ditton (1976).

ticipated for 5 years or less. Among the boat fishermen more than three-quarters (81.6 per cent) had participated for no more than 10 years.

These findings are in striking contrast to the higher levels of experience reported for fishermen in other studies (Table 6). Assuming the data from the five studies to be comparable (i.e., compatible methods of collection, etc.), there seems to be no immediate explanation for the differences. Two alternatives seem possible: (1) a trend toward increased participation on Long Island with a substantial number of new participants; or (2) an inherently high rate of turnover among the Long Island fishermen with many participating for a few years and then dropping out. Reasons for increased participation include more leisure time in the past 10-15 years (shorter work days and weeks), increased income, easier-to-handle equipment (advent of spinning tackle) and the opportunity to use sport fishing to obtain supplemental food at low cost. In any case, the pattern of participation seems to be a regional phenomenon that may be influenced by the highly urbanized, socially mobile nature of the metropolitan area that embraces New York City and Long Island.

FREQUENCY OF PARTICIPATION

In both surveys, fishermen were asked how often they went fishing during their peak season, i.e., when they personally were most involved in the sport. The data are summarized in Table 7. Surf fishermen were the more intensive participants, with 24.6 per cent of the respondents reporting that

TABLE 7. FREQUENCY OF PARTICIPATION AND DURATION OF FISHING TRIP REPORTED BY SURF FISHERMEN AND BOAT FISHERMEN ON LONG ISLAND

Item	Surf fishermen		Boat fishermen	
	Number	Per cent	Number	Per cent
Frequency of participation				
Almost every day	64	24.6	24	6.0
Once or twice a week	158	60.8	114	28.6
Once every two weeks	23	8.8	126	31.7
Once a month or less	15	5.8	134	33.7
Total	260	100.0	398	100.0
Duration of fishing trip				
One day	139	55.6	337	86.9
Overnight or weekend	92	36.8	49	12.6
Three or more days	19	7.6	2	0.5
Total	250	100.0	388	100.0

they fished almost every day and another 60.8 per cent indicating that they went once or twice a week. Boat fishermen, on the other hand, evidenced an entirely different pattern. Very few (6.0 per cent) said they participated almost every day, and the remainder were almost evenly distributed across the three categories ranging from once or twice a week to once a month or less.

Two major reasons would seem to account for these marked differences. First, surf fishermen are much less mobile in pursuing the fish they seek and depend to a large degree on schools running close to shore. It seems likely that they tend to fish as often as possible during the seasonal runs of certain species, e.g., bluefish (*Pomatomus saltatrix*) and striped bass (*Morone saxatilis*). Second, the higher average income of surf fishermen, along with their occupational and residential characteristics, suggest a greater freedom in the use of time. By the nature of their jobs and by living closer to surf-fishing areas, they may have greater opportunity to arrange vacation time and days off, or to fish after work.

DURATION OF FISHING TRIP

These data are also summarized in Table 7 and indicate that surf fishing and boat fishing are activities of short-term duration. Most fishermen of both groups reported day trips only. However, over a third (36.8 per cent) of the surf fishermen (chiefly those who fished in the vicinity of Montauk)

said they usually took overnight or weekend trips, a pattern consistent with the nature of the sport, i.e., it is not unusual for a surf fisherman to fish all night or sleep on the beach in that area.

ATTITUDES, OPINIONS AND VALUES

Several questionnaire items were designed to examine conditions that are important to fishermen in pursuing their sport.

FACTORS CONSIDERED IN MAKING A FISHING TRIP

Certain basic considerations must be met before anglers undertake a fishing trip. For each of those listed in the questionnaires, the proportion of the Long Island fishermen who rated it as very important is shown in Table 8. Surf fishermen ranked access to the shore, the chances of catching

TABLE 8. FOR EACH FACTOR LISTED, PROPORTION OF RESPONDENTS WHO CITED IT AS VERY IMPORTANT IN MAKING A FISHING TRIP*

Factor	Respondents	
	Number§	Per cent
Surf fishermen		
Access to shore	170 (257)	66.1
Chances of catching fish	123 (254)	48.4
Reputation of fishing waters	120 (251)	47.8
Camping facilities nearby	41 (249)	16.5
Travel distance	38 (258)	14.7
Cost of total trip	34 (256)	13.3
Lodging nearby	16 (244)	6.6
Other family activities in the area	14 (243)	5.8
Restaurants nearby	14 (244)	5.7
Nightlife available	6 (246)	2.4
Boat fishermen		
Chances of catching fish	232 (357)	65.0
Reputation of fishing waters	222 (358)	62.0
Reputation of boat or captain	195 (347)	56.2
Boat fee	138 (340)	40.6
Cost of total trip	144 (368)	39.1
Distance to travel	122 (372)	32.8
Nightlife available	51 (321)	15.9
Lodging nearby	42 (329)	12.8
Other family activities in the area	42 (331)	12.7
Camping facilities nearby	37 (329)	11.2

*Alternative choices: not very important, fairly important, very important.
§Figures in parentheses represent total number of respondents in each case who furnished usable data on that factor.

fish and the reputation of the fishing waters as the factors most important to them. Boat fishermen ranked the chances of catching fish, the reputation of the fishing waters and the reputation of the boat or captain as being most important to them. Other factors such as cost, travel distance and lodging services were of secondary importance to both groups.

FACTORS CONTRIBUTING TO THE FISHING EXPERIENCE

Once the decision to make a surf- or boat-fishing trip has been made, a second set of social and environmental factors determines whether the over-all experience is an enjoyable one. The degree to which the respondents considered various factors very important is shown in Table 9, and the six items common to both groups are noted according to rank in Table 10. It is significant that substantial proportions of both samples (80.6 per cent of the surf fishermen and 69.6 per cent of the boat

TABLE 9. FOR EACH FACTOR LISTED, PROPORTION OF RESPONDENTS WHO CITED IT AS VERY IMPORTANT IN CONTRIBUTING TO THE ENJOYMENT OF THE FISHING EXPERIENCE*

Factor	Respondents	
	Number§	Per cent
Surf fishermen		
Clean fishing waters	210 (260)	80.6
Pleasant companions	140 (257)	54.5
Natural beauty of the area	137 (259)	52.9
Fight put up by the fish	120 (258)	46.5
Weather conditions	83 (254)	32.7
Privacy while fishing	65 (253)	25.7
Size of fish caught	59 (255)	23.1
Number of fish caught	44 (252)	17.5
Boat fishermen		
Clean fishing waters	218 (313)	69.6
Weather conditions	205 (354)	57.9
Courteous and helpful mates	196 (349)	56.2
Courteous and helpful captain	194 (350)	55.4
Number of fish caught	201 (365)	55.1
Size of fish caught	189 (359)	52.6
Pleasant companions	171 (335)	51.0
Clean, good-looking boat	175 (346)	50.6
Ice and equipment for handling catch	155 (327)	47.4
Fight put up by the fish	160 (347)	46.1
Galley with food and drink for sale	117 (342)	34.2
Enclosed cabin for resting	113 (339)	33.3
Fishing gear for rent	93 (342)	27.2
Fishing tackle for sale	88 (324)	27.2

*Alternative choices: not very important, fairly important, very important.
§Figures in parentheses represent total number of respondents in each case who furnished usable data on that factor.

TABLE 10. FOR FACTORS NOTED IN TABLE 9, RANK ORDER FOR SURF FISHERMEN AND FOR BOAT FISHERMEN OF THOSE CITED BY BOTH GROUPS

Factor	Surf Fishermen		Boat fishermen	
	Rank	Per cent	Rank	Per cent
Clean fishing waters	1	80.6	1	69.6
Pleasant companions	2	54.5	5	51.0
Fight put up by the fish	3	46.5	6	46.1
Weather conditions	4	32.7	2	57.9
Size of fish caught	5	23.1	4	52.6
Number of fish caught	6	17.5	3	55.1

fishermen) considered clean fishing waters as being very important to the enjoyment of their fishing experience. In addition to being a general environmental prerequisite, this was probably also a reaction to the continuing problems of pollution in New York waters. It is also meaningful that the number, size and fighting quality of the fish sought were important but not predominant factors. It is interesting, however, that the relative importance of these fish-related factors differed for the surf fishermen and boat fishermen. Boat fishermen were more concerned with the size and the number of the fish caught, whereas surf fishermen put a higher value on the fighting qualities of the fish.

Salt Water Fishing License

A recurring issue in New York is whether or not to require a license for salt water sport fishing. The Long Island fishermen surveyed in this study were asked first whether they favored the idea of a salt water license and second what use should be made of the license revenue if one were required. The majority of both samples did not favor the idea, although a substantial proportion indicated that they might favor such a plan depending on how the license revenues were used (Table 11). As to the use of potential funds, the greatest support was given, especially among surf fishermen, to using the money for salt water fishing purposes only.

Table 11. Attitude of Respondents Regarding Whether or Not to Require a License For Salt Water Sport Fishing

Attitude	Surf fishermen		Boat fishermen	
	Number	Per cent	Number	Per cent
Would you favor a license?				
No, would not favor under any circumstances	140	53.6	287	75.3
Might favor, depending on what the license fee was used for	110	42.2	85	22.3
Yes, favor the plan under any circumstances	11	4.2	9	2.4
Total	261	100.0	381	100.0
If a license were required, how should the revenue be spent?				
For general State purposes	2	0.8	24	8.2
For general New York State Conservation Fund	46	18.6	55	18.7
For fishing only (salt or freshwater)	37	14.9	51	17.3
For salt water fishing only	163	65.7	164	55.8
Total	248	100.0	294	100.0

DISCUSSION

The results of the two surveys provide comparative information concern ing salt water sport fishing on Long Island and summarize the characteristics of surf fishermen and the fishermen who use party boats and charter boats. In many basic ways, the two groups are similar in their fishing habits and expectations. Nevertheless, there are enough important differences to warrant considering them as distinct groups with separate needs for enjoying their sport. However, with respect to the localities where the surveys were made, the Montauk area was represented by about 40 per cent of the surf fishermen and nearly 50 per cent of the boat fishermen who responded. The data must also be viewed in the light of two major limitations with respect to time: (1) weekday fishermen were not included in the sample; and (2) boat fishermen were not sampled during June, July and August. The latter is probably the more likely to have influenced the results. Both party-boat operators and charter-boat operators consider the Memorial Day to Labor Day period their "bread and butter days", and tourist participation would have been higher during this period. But, in terms of the times when the data were taken, it is felt that they accurately describe the characteristics of fishermen on Long Island.

In general, salt water sport fishing on Long Island appears to be a local/regional phenomenon. Most of the fishermen surveyed were from New York City or the two Long Island counties. Except for intra-regional travel for fishing, there was little evidence of tourist participation. There was little use of extended vacations for fishing or need for associated services such as motels, campgrounds and the like. Participation by boat fishermen was largely a one-day activity. Surf fishermen had a greater tendency to extend their trips over two or three days, most of which were probably spent on the beach.

The findings relating to why fishermen go fishing and what makes a good fishing trip have important implications for the quality of sport fishing in the future. In making the decision to go fishing, anglers need some reasonable expectation that they will have access to suitable shoreline or other productive waters and that they will have a chance of catching fish when they get there. Although this seems to be a rather matter-of-fact observation, it emphasizes the importance of giving careful consideration to such questions as the future of public access to coastal resources, the economic viability of the party/charter boat industry and the sustained yield of sport fish populations.

Once the expectation of catching fish has been satisfied, a second set of factors determines the enjoyment derived from participation. Some of these are inherent in the activity (e.g., the fight put up by the fish), some are individual (e.g., companionship preferences) and some are related to personal services (e.g., helpful boat personnel). Of particular relevance to the management of coastal resources is the importance that fishermen also

attach to environmental quality (e.g., clean waters and natural beauty). These findings should be useful to those responsible for natural resource administration, as well as have value for commercial sport-fishing industries in the area.

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COMPARISON OF A LEG SNARE WITH A STANDARD LEG-GRIPPING TRAP[1]

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ABSTRACT

A leg snare and a standard leg-gripping trap were field tested to compare their effectiveness and humaneness. There was no significant difference between the two devices in the incidence of trapping-related injuries. However, the leg snare was significantly less effective in capturing animals than the leg-gripping trap.

A leg snare, called the Ezyonem[2], was offered to the New York State Department of Environmental Conservation as a possible alternative to the standard steel-jawed leg-gripping trap. The device was examined in accordance with the Division of Fish and Wildlife policy to seek effective and more "humane" alternatives to the traditional steel trap for taking fur bearers. Preliminary investigation demonstrated that the leg snare could restrain a fox without causing excessive stress or injury. Since the Ezyonem leg snare and the No. 1 1/2 double coil spring steel-jawed leg-gripping trap[3] were similar in size, a standard type of set with nearly identical surface appearance for both could be developed for comparative testing under field conditions.

METHODS AND MATERIALS

Before being used, all leg snares and leg-gripping traps were checked for burrs or sharp edges. Pocket watches were modified to serve as timing devices. Each watch was wound tight, set at 12 o'clock and then stopped by inserting a pin through a 1/16-inch hole in the back and against the teeth of one of the more rapidly moving gears. The pinned watches were dipped in beeswax until they acquired a heavy protective coating.

All field testing was done in Cayuga County (N.Y.) on lands whose owners granted permission for the work to be done on their property. A search was made for signs of the three primary target animals, i.e., red fox (*Vulpes fulva*), gray fox (*Urocyon cinereoargenteus*) and raccoon (*Procyon*

[1]The authors are grateful to Elmer Davies and Michael Dandrow for assistance in developing the standard set and trap placement used in this study. They also wish to thank Angelica Leubner for assistance with the field work, Chester McCord for suggestions on using pinned pocket watches for timing devices and Dr. George Mattfeld for reviewing the manuscript.
[2]Developed by Elmer Davies and Michael Dandrow of St. Regis Falls and Minoa (N.Y.), respectively.
[3]Manufactured by Blake & Lamb, Cambridge, N.Y. 14607.

lotor). The opossum (*Didelphis marsupialis*) and skunk (*Mephitis mephitis*) were considered secondary targets. Scott (1941, 1943) described in detail signs indicating the presence of red foxes, and similar evidence applies to the other species. After sufficient sign was located, trap sites were selected. Trap sites were areas that the target animals would approach and where the ground would permit the digging and stake driving required to deploy the traps. Areas that showed the most sign and contained two similar trap sites from 6 to 30 feet apart were chosen as set locations. At each set location, a leg snare was set at one trap site and a leg-gripping trap at the other, the two types being alternated at the first site selected at successive locations.

All sets were of the dirt-hole type, similar to that described by Seagears (1944). At each a bait hole, 5 to 8 inches deep and from 1 1/2 to 2 inches wide, was dug at a slope of 30 degrees from the horizontal, and the excavation for the trap was made as close as possible to it. The excavation for the leg-gripping trap was 3 inches deep, 8 inches wide and 8 inches long, while that for the leg snare was the same size but included a small extension to accommodate part of the mechanism. This hole was 1 1/2 inches wide and from 5 to 6 inches deep, and was also dug at a 30-degree slope. A 15-inch steel stake and a 9-inch chain (containing two swivels) were used to anchor each trap. The stake was driven into the ground in the trap excavation, but to the right of the bait hole and about 2 inches below the ground level. The leg-gripping traps were concealed in front of the bait hole, while the snares were concealed under and in front of it. Each trap was firmly seated in its excavation. A strip of unscented toilet paper or wax paper was used to cover the entire tripping mechanism in each case. A pinned watch was installed between the stake and trap with two 3-inch pieces of wire, one securing the watch to the stake and the other attaching the pin to the trap. A snap swivel at the end of each wire made it easier to attach the watch after the trap was set. This method of attachment allowed very little slack in the wires between the trap, watch and stake; therefore the pin was pulled as soon as the animal moved the trap.

Although the excavations for the two traps were slightly different, they were usually covered with sifted soil (taken from the set location and sifted through 1/4-inch-mesh hardware screening) in such a manner as to make both sets look identical. Sets had a 1-inch depression, in the sifted soil, over most of the trap except the tripping mechanism where there was a 1 1/2-inch depression. Only 1/8 inch of soil covered any part of the tripping mechanism. Depressions on all sets were made as similar as possible. At some set locations, sets made specifically for raccoon were not covered and these were evaluated separately.

Approximately an hour was required to deploy the two traps with their timing devices at a set location. The Ezyonem leg snare required more time than the other because it involved extra digging and was more difficult to

reset when staked. A trap of each type was set at 66 different set locations, some being maintained for as many as 29 nights. The test totalled 543 trap nights for each type at the sites where the traps were covered, and 41 trap nights where they were not covered.

All traps were visited daily by the senior author as soon as possible after 8:00 a.m. and again at mid-day. Most of the captured animals were restrained with a handling noose, but skunks were shot. All were examined for physical injury, and the limb caught in the trap was photographed. A record was made for each, including: species, sex and approximate age; time the trap was checked; the time shown on the watch and the number of revolutions required to completely rewind it; a description of any injury to the animal; and the film exposure numbers for all photographs taken. If the trap was empty, the sifted soil covering was examined and signs of visits or disturbances were recorded. An attempt was made to identify and record all species of animals that visited each trap.

Chi square procedures as described by Steel and Torrie (1960) and Walker and Lev (1953) were used for all statistical comparisons.

RESULTS AND DISCUSSION

As initially planned, there would have been a usable record for all captures of the amount of time the animal had spent in the trap which could then have been compared with the incidence and extent of trap-related injuries. However, due to the extra time required to prepare and attach the timing devices, only 417 (35.7 per cent) of the trap nights involved their use. These trap nights resulted in 39 captures of which 23 had usable time records. The 16 non-usable records included: two cases in which the pin was pulled (but went undetected) while the trap was being deployed; four cases in which captured raccoons destroyed the timing device; and 10 cases in which the watch failed to run or stopped running when it was reused without internal cleaning.

The 23 usable records ranged from 3 hours and 20 minutes to 13 hours and 22 minutes, with an average of 8 hours and 27 minutes. These data showed that both the No. 1 1/2 leg-gripping trap and the Ezyonem leg snare were capable of catching and holding an animal for over 12 hours without causing any visible injury or excessive stress. It has been commonly thought that the longer an animal is held in a leg-gripping trap the greater the liklihood that it will chew its trapped foot. However, the data from this study did not support this contention. One raccoon was captured without any laceration or fracture, but it had already started chewing its toes and foot within 3 hours and 32 minutes. Three other raccoons were known to have been held for longer periods, up to 12 hours, and none had chewed any part of its feet or toes.

Most assessments of trap effectiveness are made by comparing catches per trap night. For this type of comparison to be valid, however, the traps

must be deployed in such a manner as to provide each with the same opportunity to be visited by a target animal. The importance of trap placement was illustrated by the 50 site-dependent variables affecting the trap responses of gray squirrels (*Sciurus carolinensis*) described by Perry et al. (1977). For comparing the effectiveness of small mammal traps, Pruitt and Lucier (1958) alternated traps set on a marked grid system, and Sealander and James (1958) set traps side by side. Casto and Presnal (1944) deployed two kinds of traps in paired positions as nearly identical as possible for testing their effectiveness in taking coyotes (*Canis latrans*). These authors felt that their methods provided an equal opportunity for each trap to be visited. The method used during the present study was similar to that of Casto and Presnall (1944) except that the type of trap used at the first trap site selected was alternated because the first one chosen might have been

Table 1. Comparative Effectiveness of No. 1 1/2 Double Coil Spring Leg-gripping Trap and Ezyonem Leg Snare

Species	Type of trap	Visits	Captures		
			Number	Number per visit	Chi square§
Traps covered (543 trap nights)					
Red fox	Leg-gripping	39	15	0.39	7.60**
	Leg snare	30	2	0.07	
Gray fox	Leg-gripping	21	13	0.62	9.71**
	Leg snare	16	1	0.06	
Raccoon	Leg-gripping	28	17	0.61	14.52**
	Leg snare	22	1	0.05	
Opossum	Leg-gripping	19	15	0.79	5.21*
	Leg snare	6	1	0.17	
Skunk	Leg-gripping	20	6	0.30	2.96
	Leg snare	13	0	0.00	
Miscellaneous	Leg-gripping	42	6‡	0.14	6.46*
	Leg snare	58	0	0.00	
Total	Leg-gripping	169	72	0.43	
	Leg snare	145	5	0.03	
Traps not covered (41 trap nights)†					
Raccoon	Leg-gripping	17	12	0.71	
	Leg snare	9	1	0.01	6.12*
Miscellaneous	Leg-gripping	3	3‡	1.00	
	Leg snare	2	0	0.00	
Total	Leg-gripping	20	15	0.75	
	Leg snare	11	1	0.09	

§Values adjusted according to Yates' correction (Walker and Lev, 1953).
**Significantly different ($P < 0.01$).
*Significantly different ($P < 0.05$).
†Sets made specifically for raccoon.
‡Included one domestic dog, three domestic cats, one woodchuck and one crow for covered traps, and three cottontail rabbits for traps not covered.

the better site. All traps were set by the senior author to avoid variation in proficiency, a problem suggested by Snead (1950).

The total number of visits by each target species to each type of trap is listed in Table 1; a visit was recorded when an animal was captured or left a detectable track within 12 inches of the trap or bait hole. There was no significant difference between the two types of traps with respect to the total number of visits at the covered sets. However, it was more difficult to detect visits of opossums and skunks than those of foxes or raccoons if the animal was not captured. At the uncovered sets, both visits by and captures of raccoons were notably greater for the leg-gripping traps. Due to the differences in the number of visits, all comparisons were made in terms of catch per visit.

The number of captures and the number per visit are also given in Table 1 by species for each type of trap. The leg-gripping traps were markedly more effective than the leg snares in taking all species. This difference was due in part to the much smaller tripping mechanism of the leg snare. In Table 2, the two types are compared with respect to the outcome of instances in which the trigger was known to have been stepped on. Although the number of such records for the leg snare was less than half that for the other, these data also clearly indicate the leg-gripping trap to have been superior in capturing animals. Rusting of the tripping mechanism on the snare may have reduced its effectiveness to begin with, but there was no apparent increase in the catch after this problem was solved by replacing the original steel fastenings with brass fittings.

Data were also recorded for miscellaneous (non-target) species, and these are summarized in Table 1. Such species visited the leg snares more often than the leg-gripping traps, but the number taken per visit (zero vs. 0.20) was greater for the latter. There was little difference in the catches of target and non-target species by the leg snares. However, for the leg-gripping traps, the catch per visit of target species (0.54) was significantly greater than that (0.20) of non-target species. Therefore, when deployed under the methods described, the No. 1 1/2 leg-gripping trap was the more selective in capturing the target species.

Part of the purpose of this trap evaluation was to compare the humaneness of the two traps. However, no attempt was made to label either device as a "humane trap" or a "gentle trap". Any trap, regardless of

TABLE 2. RELATIVE EFFICIENCY OF LEG-GRIPPING TRAPS AND LEG SNARES AS INDICATED BY RESULTS IN INSTANCES IN WHICH TRIGGER WAS KNOWN TO HAVE BEEN STEPPED ON

Result	Leg-gripping trap		Leg snare	
	Number	Per cent	Number	Per cent
Animal captured	87	85.3	6	13.6
Trap failed to hold animal	14	13.7	27	61.4
Trap failed to spring	1	1.0	11	25.0
Total	102	100.0	44	100.0

its design, may be used "inhumanely", and the circumstances under which it is deployed may have as much or more bearing on "humaneness" than the trap itself.

Trapping-related injuries, i.e., inflicted by the trap or self inflicted, were the chief criteria used. The total catch and all observed injuries are listed in Table 3 according to the species and type of trap. Due to the difficulty of restraining the trapped animals without drugs, no attempt was made to thoroughly examine their teeth. However, no bleeding from the mouth or tooth damage was noticed while handling them. Both traps did cause some skin lacerations although no burrs or sharp edges were found on any of those used.

The fact that only six animals were captured with the leg snare made comparisons difficult. However, considering the numbers caught, there was no significant difference in the incidence of trapping-related injuries,

TABLE 3. COMPARATIVE INCIDENCE OF INJURIES TO ANIMALS CAPTURED WITH NO. 1 1/2 DOUBLE COIL SPRING LEG-GRIPPING TRAP AND EZYONEM LEG SNARE

Species	Type of trap	Number captured	Injury				
			None	Laceration§			Chewing
				Minor	Moderate	Fracture	
Traps covered							
Red fox	Leg-gripping	15	3	10	2	0	0
	Leg snare	2	1	1	0	0	0
Gray fox	Leg-gripping	13	6	7	0	0	0
	Leg snare	1	1	0	0	0	0
Raccoon	Leg-gripping	17	7	4	0	1	6
	Leg snare	1	0	1	0	0	1
Opossum	Leg-gripping	15	10	2	0	3	0
	Leg snare	1	1	0	0	0	0
Skunk	Leg-gripping	6	0	0	0	0	6
	Leg snare	0	0	0	0	0	0
Miscellaneous†	Leg-gripping	6	6	0	0	0	0
	Leg snare	0	0	0	0	0	0
Total	Leg-gripping	72	32	23	2	4**	12
	Leg snare	5	3	2	0	0	1
Traps not covered							
Raccoon	Leg-gripping	12	2	2	0	10	5
	Leg snare	1	0	1	0	0	0
Miscellaneous†	Leg-gripping	3	1	1	0	1	0
	Leg snare	0	0	0	0	0	0
Total	Leg-gripping	15	3	3	0	11**	0
	Leg snare	1	0	1	0	0	0

§Minor = Less than 1/2 inch long; moderate = 1/2-1 inch long.
**Incidence of fractures significantly different ($P < 0.01$) for covered vs. uncovered leg-gripping traps.
†See Table 1 for species involved.

and therefore humaneness, between the two traps. Of the six animals, three had no visible injury, and the others had only minor skin lacerations although one, a raccoon, had chewed its foot. While these injuries did not differ from those encountered with the No. 1 1/2 leg-gripping trap, they do appear to be far more acceptable than those produced by a chain-noose leg snare and a larger leg-gripping trap as reported by Casto and Presnall (1944). It is possible that a larger Ezyonem leg snare might result in fewer trapping-related injuries than a larger (than No. 1 1/2) leg-gripping trap.

The leg-gripping traps captured 87 animals and provided a better opportunity to observe trapping-related injury and stress. Of these, 35 (40.2 per cent) had no visible injury, 26 (29.9 per cent) had minor and 2 (2.3 per cent) moderate skin lacerations, 15 (17.2 per cent) had fractures and 17 (19.5 per cent) had chewed their feet or toes (Table 3). Most lacerations were oblique across the foot held in the trap. However, it was apparent that these injuries did not occur when the trap closed on the foot because the jaws would have gripped it transversely. The struggling of the trapped animal caused its foot to align with the chain of the trap (Figure 1), and this movement from transverse to oblique sometimes produced an oblique laceration. Some lacerations of this sort could be prevented by moving the

Figure 1. Leg of gray fox aligned with chain of No. 1 1/2 leg-gripping trap.

chain attachment to the center of the trap and by increasing the strength of the trap springs. For the leg-gripping traps, significantly fewer fractures were associated with those that had been covered with sifted soil than with those that had not been covered. Only skunks and raccoons had chewed

parts of their limbs held in traps, and the authors believe that some chewing could have been prevented by using drags such as described by Sampson and Brohn (1955) and long chains.

Complete records were not kept of the activities of the trapped animals as the trapper approached. However, at least one red fox, one gray fox, one raccoon and one skunk were observed sleeping while being held in leg-gripping traps. None of these animals appeared to have been suffering from shock or exhaustion. This sleeping did not indicate that the animals were completely without stress, but it may have been a displacement activity that reduced stress. Other displacement activities noticed were stick chewing and digging.

Bateman (1971) suggested that live trapping small mammals and birds was humane because some animals became trap-prone. Although there were no cases of animals becoming trap-prone during the present study, three foxes were caught in leg-gripping traps twice. A male gray fox was trapped twice in 12 days, a female red fox pup was trapped twice in 10 days and an adult male red fox was trapped twice in six days. In another study (unpublished), the authors found that red fox pups, after being trapped, tagged and released, were recovered by fur trappers at the same rate as red fox pups that were excavated from dens, tagged and released. This suggests that if the trapping does stress foxes, it does not stress them enough to preclude their recapture.

CONCLUSIONS

The Ezyonem leg snare was found to be less effective than the No. 1 1/2 double coil spring leg-gripping trap for capturing red foxes, gray foxes, raccoons and opossums. The catch of target species was significantly greater than that of non-target species with the leg-gripping trap, but not with the leg snare. The Ezyonem leg snare did not appear to be more humane than the No. 1 1/2 leg-gripping trap since both produced similar trapping-related injuries. However, the leg-gripping traps caused fewer fractures when they were covered with 1/4 to 1/2 inch of sifted soil.

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FECUNDITY OF AN UNEXPLOITED POPULATION OF CISCOES IN THREE AREAS OF LAKE CHAMPLAIN

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ABSTRACT

Estimates of fecundity for ciscoes in three areas of Lake Champlain were based on examination of 108 specimens collected prior to spawning in 1976 and 1977. Absolute fecundity ranged from 6,932 to 24,868 eggs per female. Mean relative fecundity was 56.3 eggs per gram of body weight, which is higher than that reported for exploited populations in the Great Lakes. Based on logarithmic values, absolute fecundity increased linearly with length and weight, but not with age. Ciscoes in eutrophic Malletts Bay were fewer in number, smaller and less fecund, and had a lower condition factor, than those in the Main Lake and Northeast Arm which are mesotrophic to oligotrophic.

The cisco (*Coregonus artedii*) has long been a valuable commercial fish in the northern Midwest, and there are numerous accounts of various aspects of its biology, e.g., Van Oosten (1929), Hile (1936), Frey (1955), Smith (1956). Its fecundity has previously been reported by Cahn (1927), Brown and Moffett (1942), Stone (1938), Scott (1951) and Smith (1956). However, most of the earlier studies were carried out on commercially exploited stocks in the Great Lakes. In contrast, the cisco population in Lake Champlain has been virtually unexploited and little is known of its biology. In order to assess the potential of the species to support a commercial fishery in the lake, the authors began a study of its life history in October 1976. This paper presents the findings of a portion of that study.

STUDY AREA

Lake Champlain is a typically dimictic lake of 1,140 square kilometers bordered by the states of New York and Vermont as well as the province of Quebec (Canada). Maximum depth is 122 meters, and mean depth is 22 meters. Maximum surface temperature is about 25° C. It has been described (Potash et al., 1969) as being composed of five distinct water masses each characterized by distinct limnological parameters (Figure 1). The "Main Lake" is a large, deep, well oxygenated area with an epilimnion typically 8 to 12 meters deep. Hypolimnetic oxygen concentrations usually remain near saturation. The Northeast Arm is an area of about 270 square kilometers connected to the Main Lake through two narrow passages and to Malletts Bay via a narrow channel. It is generally well oxygenated although hypolimnetic oxygen concentrations as low as 45-48 per cent of saturation have been reported (Potash et al., 1969). Malletts Bay is

Figure 1. Map of Lake Champlain showing areas where ciscoes were collected.

a circular basin of about 47 square kilometers with a mean depth of 14 meters that is connected to the Main Lake by two narrow passages. It is highly eutrophic, and hypolimnetic oxygen concentrations have been found to decrease to 0.1-0.2 milligrams per liter at 1 meter above the bottom from the time of spring stratification until the fall overturn (Potash et al., 1968). Both the Main Lake and Northeast Arm supported large populations of ciscoes, but the fish were much less abundant in Malletts Bay. The remaining two areas, South Lake and Missisquoi Bay, were not included in this study.

METHODS

Ciscoes used for fecundity analysis were collected from the Main Lake, Northeast Arm and Malletts Bay of Lake Champlain prior to spawning in 1976 and 1977 using a midwater trawl, horizontal gill nets and vertical gill nets. Both ovaries were removed from each female, and its total body length and weight were taken. Scales were removed from the left side between the dorsal fin and the lateral line for age determination. Ovaries collected in 1976 were preserved in 5 per cent formalin until egg counts were

made, while those collected in 1977 were preserved in Gilson's Fluid (Galigher and Kozloff, 1964: p. 101) to facilitate breaking the ovarian tissue.

Estimates of fecundity were made by counting the eggs in weighed aliquots of the ovaries. Prior to counting, each ovary was rinsed in fresh water, allowed to drain for 5 minutes and weighed to at least the nearest 0.1 gram. For a given ovary, the eggs in three aliquots of approximately 2 grams each were counted and the number per gram calculated which was then multiplied by the ovary weight to obtain the total number present. This method was tested by counting the eggs in seven whole ovaries. The seven counts yielded an average error of -9.7 per cent, i.e., based on aliquots the total number of eggs was underestimated by an average of that amount. Absolute fecundity was expressed as the number of eggs per female, and relative fecundity as the number of eggs per gram of body weight.

Absolute fecundity was plotted against length, weight and age in scatter diagrams. All variables were transformed to logarithmic forms as described by Baxter and Hall (1960) and Pope et al. (1961), and linear regressions were computed. Regression coefficients from different years and different areas of the lake were compared by the Student's t-test (Dixon and Masey, 1951). Multiple regression was used to determine which of the independent variables had a greater effect on the variation in fecundity.

RESULTS

The regressions for the relationships of length, weight and age to absolute fecundity did not vary significantly between 1976 and 1977 ($P < 0.10$) so the data for the two years were treated together. The combined sample totalled 108 mature female ciscoes.

Mean length was 297.3 millimeters, mean weight was 231.0 grams and age ranged from 3 to 6 years. Mean absolute fecundity was 12,973 eggs per female with a range of 6,932 to 24,868. Mean relative fecundity was 56.3 eggs per gram of body weight with a range of 27.4 to 80.6. The data are given in Table 1. Absolute fecundity was positively and highly correlated with length and weight, but not age (Table 2). Linear regression for log transformed data best described the relationships between length and weight and absolute fecundity. The equations were:

$$\log F = -4.998 + 3.679 \log L$$
$$\log F = 1.834 + 0.961 \log W$$

where:

F = absolute fecundity
L = length in millimeters
W = weight in grams

TABLE 1. RELATIONSHIP OF LENGTH TO ABSOLUTE FECUNDITY AND RELATIVE FECUNDITY FOR CISCOES IN LAKE CHAMPLAIN*

Total length (millimeters)	Number	Absolute fecundity§		Relative fecundity†	
		Mean	Range	Mean	Range
261-270	3	9,624	7,992-12,745	58.7	52.4-67.1
271-280	16	9,987	6,932-12,476	57.1	43.4-70.1
281-290	15	11,310	7,898-15,532	57.8	41.4-77.7
291-300	33	12,351	7,234-19,354	55.1	36.2-80.6
301-310	22	14,843	7,130-23,959	57.1	27.4-80.4
311-320	14	14,308	9,912-15,903	51.9	33.2-74.7
321-330	1	21,787	. .	67.7	. .
331-340	2	19,818	15,415-24,221	67.7	64.2-71.2
341-350	1	22,073	. .	61.3	. .
351-360	1	24,868	. .	54.1	. .
Total	108	12,973	6,932-24,868	56.3	27.4-80.6

*Specimens collected in Main Lake, Northeast Arm and Malletts Bay.
§Number of eggs per female.
†Number of eggs per gram of body weight.

TABLE 2. MATRIX OF CORRELATION COEFFICIENTS FOR REGRESSION OF ABSOLUTE FECUNDITY ON LENGTH, WEIGHT AND AGE OF CISCOES FROM LAKE CHAMPLAIN

Factor	Weight	Age	Absolute fecundity
Length	0.856	0.362	0.661
Weight	. .	0.408	0.746
Age	. .	. .	0.306

Figure 2 shows a scatter diagram and fitted regression line for the relationship of absolute fecundity to length.

The relationship of the three independent variables (length, weight and age) to absolute fecundity as determined by multiple regression was described by the following linear model.

$$F = 290.121 + 54.914W \qquad R^2 = 0.746$$
$$F = -5035.129 + 22.139L + 49.472W \qquad R^2 = 0.747$$
$$F = -5035.132 + 22.139L + 49.472W + 0.005A \qquad R^2 = 0.747$$

Thus, 74.6 per cent of the variations in absolute fecundity were related to weight independently of length and age, 74.7 per cent to length and weight independently of age, and 74.7 per cent to the three variables together.

The relationship of length and weight to absolute fecundity, based on logarithmic values, for each of the three sampling areas treated separately is shown in Table 3. There were no significant differences among the regression equations ($P < 0.20$), indicating that the number of eggs per female increased with length and weight at equal rates in these areas of the lake.

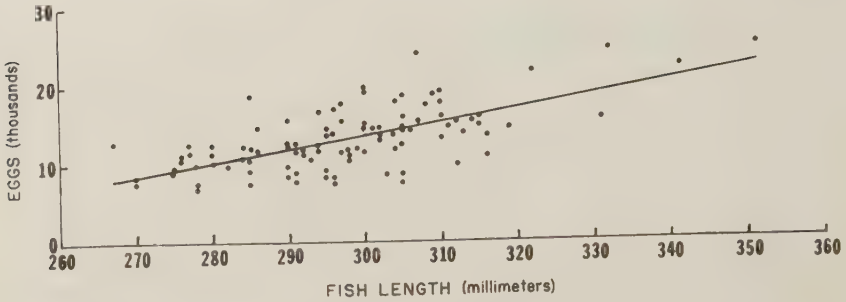

Figure 2. Scatter diagram and fitted regression line for relationship of absolute fecundity to length for ciscoes from Lake Champlain.

TABLE 3. REGRESSION ANALYSIS (BY LEAST SQUARES) OF THE RELATIONSHIP OF LENGTH AND WEIGHT TO ABSOLUTE FECUNDITY FOR CISCOES FROM LAKE CHAMPLAIN*

Area	Number	Length-fecundity			Weight-fecundity		
		Slope	Intercept	Correlation coefficient	Slope	Intercept	Correlation coefficient
Main Lake	24	3.45	− 44.41	0.83	0.90	2.00	0.83
Northeast Arm	55	4.11	− 6.05	0.61	1.10	1.51	0.71
Malletts Bay	29	4.03	− 5.91	0.56	1.04	1.65	0.58

*Based on logarithmic values.

TABLE 4. COMPARISON OF LENGTH, WEIGHT, ABSOLUTE FECUNDITY AND RELATIVE FECUNDITY FOR CISCOES FROM THREE AREAS OF LAKE CHAMPLAIN§

Area	Length	Weight	Absolute fecundity	Relative fecundity
Northeast Arm				
Main Lake	3.06*	2.63*	1.11	− 1.86*
Malletts Bay				
Main Lake	1.45	− 0.84	− 1.06	0.83
Northeast Arm	1.60	5.46*	2.82*	-0.63

§Comparison by Student's *t*-test (Dixon and Massey, 1951).
*Significant ($P < 0.05$).

TABLE 5. MEAN VALUES FOR LENGTH, WEIGHT AND ABSOLUTE FECUNDITY OF CISCOES FROM THREE AREAS OF LAKE CHAMPLAIN

Area	Number	Mean		
		Length	Weight	Absolute fecundity
Main Lake	24	289.6	217.4	12,780.1
Northeast Arm	55	300.9	251.0	13,806.0
Malletts Bay	29	296.8	204.1	11,555.0

Ciscoes from the Main Lake showed a significantly lower mean length and weight than those from the Northeast Arm ($P < 0.05$), but they were not different from those from Malletts Bay (Tables 4 and 5). Ciscoes from the Northeast Arm had a significantly higher mean weight and absolute fecundity than those from Malletts Bay ($P < 0.05$).

DISCUSSION

These data indicate that ciscoes in Lake Champlain produce more eggs per gram of body weight (56.3) than do those from the Great Lakes where corresponding values have been reported as follows: 48.3 in Irondequoit Bay, Lake Ontario (Stone, 1938); 54.5 in Lake Erie (Scott, 1951); 35.7 in Green Bay, Lake Michigan (Smith, 1956); and 29.7 in Lake Superior (Dryer and Beil, 1964). All of these populations had been highly exploited commercially which may have led to changes in the population structure. Van Oosten (1929) reported that there was a paucity of older age groups among ciscoes in Lake Huron due to overexploitation, and Clady (1967) found that, during periods of low population density in an exploited population of ciscoes in Birch Lake, Michigan, males matured at a younger age than when population densities were high. To what extent these changes affect fecundity is not entirely known.

Absolute fecundity for other populations of ciscoes has been reported as 13,423 to 48,999 eggs per female in Irondequoit Bay for fish having a mean length of 340 millimeters (Stone, 1938) and 3,471 to 11,217 eggs per female in Green Bay (Smith, 1956). However, since absolute fecundity is closely dependent on fish size, one should use caution when comparing values for different populations.

The present data show that, although fecundity did not vary greatly between the ciscoes in the Main Lake, Northeast Arm and Malletts Bay of Lake Champlain, a tendency was evident for those in Malletts Bay to be smaller and less fecund than the others. Ciscoes have been found to require temperatures of less than 20° C. and dissolved oxygen concentrations of more than 3 ppm (Frey, 1955). The fact that the hypolimnion in Malletts Bay becomes nearly anoxic throughout the summer may have an adverse effect on the population there. Data collected thus far for 1,615 ciscoes from Lake Champlain show that fish from Malletts Bay had the lowest mean condition factor, i.e., 0.77 compared with 0.80 for the Main Lake and 0.85 for the Northeast Arm. However, insufficient data are presented here to more than suggest the effects of environmental conditions on the fecundity of the cisco populations in Lake Champlain.

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CHARACTERISTICS OF SPORT AND COMMERCIAL FISHERMEN RESIDING ON EASTERN LONG ISLAND, NEW YORK[1]

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ABSTRACT

A multiple-choice questionnaire designed to obtain information on fishermen living on eastern Long Island and their angling preferences was mailed to a random sample of households in the towns of Riverhead, Southold, Southampton, Shelter Island and East Hampton. Of 1,823 questionnaires delivered, 46 per cent were completed and returned, and from the data it was estimated that there were 50,750 saltwater anglers residing in the five towns surveyed. Respondents averaged 22 trips per year of which 96.9 per cent were one day or less in duration, representing an estimated 1,116,508 fishing trips by local anglers in 1977 at an expense of some $12,281,600. A substantial proportion of the recreational fishermen (48.6 per cent) favored a saltwater fishing license, and 81.6 per cent favored regulations fixing minimum size and daily catch limits. Response by commercial fishermen was poor (5 per cent), but respondents strongly favored establishing exclusive fishing zones, licensing recreational shellfishermen and a marine commercial fishing license if the revenue from it were used for reseeding shellfish beds.

It has been estimated that there are approximately 2,980,000 marine recreational fishermen in New York State (National Marine Fisheries Service, 1975) and well over 12 million saltwater anglers nationally (Sport Fishing Institute, 1977). Lack of user information and catch statistics for the marine recreational fishery represents two of the most serious obstacles to developing a national marine fisheries policy. Similarly, statistical data on the recreational fisheries in Long Island waters are needed for formulating management policy and priorities there (Ginter, 1974).

A primary consideration with respect to a management program for eastern Long Island is input from the marine recreational fishermen. User needs and preferences must be known before responsible decisions can be made, as has been pointed out by Moeller and Engelken (1972) and McFadden et al. (1964) with respect to freshwater fisheries. As emphasized by Hampton and Lackey (1975), fisheries management has progressed beyond the point of maintaining, enhancing or reestablishing fish populations and habitat. Such factors as aesthetics, crowding, companionship, motivation and any others that affect the quality of the angling experience must be considered. Hendee (1974) noted that it is the ultimate purpose of management to provide benefits to the user populations. These studies

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have all shown that angling is a multidimensional experience with the catch being only one factor. The present study was undertaken to identify the needs and preferences of fishermen living in the region and to provide data for orienting research and management priorities and directions.

METHODS

A questionnaire was mailed to 2,098 residents of the towns of Riverhead, Southold, Southampton, Shelter Island and East Hampton in Suffolk County, (N.Y.) that comprise the easternmost third of Long Island. The study represented a modification of the techniques outlined by Duttweiler (1976). The design of the questionnaire and other procedures were taken from Parten (1966) The sample was selected by a random procedure from telephone directories. Since more than 95 per cent of all households in this area had telephones (U.S. Bureau of Census, 1973), it was felt that a sample obtained by this method would be representative. Sample size was determined by the procedures and tables in Parten (1966) representing a 95 per cent confidence level. To avoid bias, sampling was in direct proportion to the relative populations of the towns according to the 1970 census (U.S. Bureau of Census, 1973). To maximize response, the questionnaire included an addressed return envelope (business reply mail). Follow-up efforts included sending two reminder letters to non-respondents. Parten (1966) suggested that follow-up letters are of much greater value in securing returns than the original questionnaire.

The questionnaire consisted of four sections with a total of 47 questions. The first section included 15 questions and was designed to provide data on the characteristics of the survey population. Respondents were asked to classify themselves as non-fishermen, recreational fishermen, commercial fishermen or recreational/commercial fishermen. Non-fishermen were defined as individuals who had not fished, either recreationally or commercially, during the previous 10 years. The second question applied to recreational fishermen and consisted of 19 questions on such topics as motivation for angling, type of fishing and species sought, degree of effort, cost, disposition of catch and attitude toward licensing. The third section applied to commercial fishermen and consisted of 13 questions including species sought and gear used, as well as preferences with respect to such topics as the 200-mile extended national jurisdiction in coastal waters, a marine commercial fishing license, landings reports and fishing regulations. Specific questions and the responses received can be found in Panek and Lamson (1978) along with appropriate measures of standard error. The fourth section provided for comments in the hope that they might be useful in identifying problems not covered by the questionnaire and act as an incentive for returning the form.

Of the 2,098 questionnaires mailed, 1,823 (86.9 per cent) were deliverable and 275 (13.1 per cent) were returned due to incorrect or lack

of forwarding addresses. Responses totalled 839, representing 46.0 per cent of the deliverable questionnaires. The data are summarized by town in Table 1.

CHARACTERISTICS OF RESPONDENTS

As shown in Table 1, the relative distribution of the respondents among the five towns parallelled that of the population. Of the 839 respondents, 84.6 per cent were male and 90.7 per cent were over 31 years of age, 33.3 per cent being over 61 years old. A substantial number (34.6 per cent) had

TABLE 1. COMPOSITION OF THE SURVEY POPULATION BY TOWN TOGETHER WITH CORRESPONDING NUMBER OF QUESTIONNAIRES MAILED AND DEGREE OF RESPONSE

	Population*		Questionnaires			Respondents		
				Delivered				
Town	Number	Per cent	Number mailed	Number	Per cent§	Number	Per cent†	Percentage response‡
East Hampton	10,980	13.0	273	224	12.3	100	11.9	44.6
Riverhead	18,909	22.4	470	430	23.6	194	23.1	45.1
Shelter Island	1,644	1.9	40	69	3.8	36	4.3	52.2
Southampton	36,154	42.8	898	763	41.8	339	40.4	44.4
Southold	16,804	19.9	417	337	18.5	170	20.3	50.4
Total	84,491	100.0	2,098	1,823	100.0	839	100.0	46.0

*In 1970 (U.S. Bureau of Census, 1973).
§Of total questionnaires delivered.
†Of total respondents.
‡Of total who received questionnaire in each town.

attended at least high school, while 22.3 per cent had attended college, 15.5 per cent graduate school and 4.5 per cent either law or medical school. Slightly more than half (58.8 per cent) had lived on eastern Long Island for over 10 years. The average family size was 3.03 individuals of whom 1.82 reported that had fished sometime within the preceding 10 years. This compared with 2.19 anglers per household as reported by the National Marine Fisheries Service (1975).

Of the 839 respondents, 570 (68.0 per cent) considered themselves saltwater anglers, 227 (27.0 per cent) said they were non-fishermen and only 42 (5 per cent) claimed commercial fishing status. Although not directly comparable, the U.S. Fish and Wildlife Service (1970) estimated that 34 per cent of households included fishermen.

The respondents expressed concern about the quality of their environment. The discharge and dumping of garbage, sewage and industrial wastes into marine waters was considered the most serious environmental problem facing Long Island. Other concerns ranked in order of importance included: unregulated wetland and beach dune development, construction of offshore facilities, nuclear power plants and poorly enforced commercial fishing regulations. The majority (67.9 per cent) felt that

government had not publicly made clear their goals and objectives in managing marine and coastal resources.

The respondents strongly favored (91.4 per cent) additional research and development with respect to aquaculture as a means of supplementing natural reproduction and enhancing marine life. Research and development of the commercial aspects of aquaculture was not as strongly favored (75.5 per cent) but was still supported. The level of indecision on its role as a commercial industry was twice that regarding its use as a means of augmenting natural stocks. About 64 per cent of the respondents indicated that they thought present shellfish reseeding programs were beneficial to both commercial and recreational shellfisheries.

RECREATIONAL FISHING

The views of the recreational fishermen are summarized according to various aspects of the fishing done and their attitude toward licensing and regulation.

Quality of the Angling Experience

Of the 570 recreational fishermen who returned questionnaires, 33.8 per cent considered catching fish for sport as the best reason to go fishing. Next were individuals who fished for food (29.7 per cent) and those who fished just to have an enjoyable day outdoors (22.2 per cent). Less than 1 per cent sought trophy fish. This agrees with the findings of Ferris (1963) which indicated that people fish mostly to catch fish, and with data on angling preferences reported by the Sport Fishing Institute (1976). When asked what constitutes an enjoyable fishing trip, the majority (50.4 per cent) stated that having an unpolluted natural area readily accessible was the primary prerequisite. Only 26 per cent considered catching either large fish or great numbers of fish as an important criterion of fishing satisfaction.

Type of Fishing and Species Sought

Several types of fishing are available to fishermen in New York's marine waters. These include bank and pier fishing, surf casting, rowboat fishing, private or charter boat fishing and party boat fishing. Results of this survey indicated that fishing from private boats was the method most commonly used by anglers on eastern Long Island. Other types, ranked in order of preference, were: bank and pier fishing, surf casting, rowboat fishing and party boat fishing. The party-boat industry was apparently supported by anglers who resided outside the area.

Respondents sought a wide variety of marine species. Those most popular, in order of preference, were bluefish, striped bass, weakfish, fluke, winter flounder, tautog, tuna, Atlantic cod, puffer, mackerel and

black sea bass. The respondents expressed little interest in scup, bonito, butterfish, sea robin, hake (whiting), marlin or shark. However, Briggs (1968) found that scup ranked first in the catch of anglers in the waters of eastern Long Island during the years 1964 to 1966. Since then, according to McHugh (1972), the scup population has declined, and sport fishing for this species is apparently decreasing in popularity. In general, shark and marlin fishing is a minor activity among local fishermen, but it is considered an important sport fishery in the Montauk area where deep-water fishing by anglers from outside the survey area is a major pursuit. Scup, bonito, butterfish and whiting are important commercial fish on eastern Long Island and are actively sought by trawlers and pound-net fishermen.

Species usually harvested by anglers living in the area included bluefish, weakfish, winter flounder, fluke, striped bass, sea robin, tautog, mackerel and puffer. Bluefish were taken most frequently and puffers least. Respondents indicated that 96.5 per cent of their catch was either consumed or distributed to friends and relatives. Sales of fish taken by angling to local restaurants and fish markets has long been a controversial issue between sport and commercial fishermen on Long Island, but only 1.0 per cent of the respondents said that they did this.

ANGLER PARTICIPATION AND ECONOMIC VALUES

As noted under a previous topic, responses to the present questionnaire indicated averages of 3.03 individuals and 1.82 fishermen per household. Applying these values to the total population of 84,491 for the five towns surveyed as reported for 1970 by the U.S. Bureau of Census (1973) gives an estimate of 50,750 as the number of saltwater anglers residing in this area. Hence, some 60 per cent of the population of eastern Long Island participated in recreational marine fishing.

Respondents averaged 22 fishing trips per year, of which 96.9 per cent were one day or less in duration. Seasonal distribution of trips was 48.7 per cent in summer, 29.0 per cent in spring, 19.0 per cent in fall and 3.2 per cent in winter. The total number of trips per year by anglers residing in the towns surveyed was estimated by the following equation

$$FT = \frac{T(N)}{h_n} \times h_f$$

where:

FT = total number of annual fishing trips
T = average number of trips per year (22)
N = population of towns surveyed (84,491)
h_n = number of individuals per household (3.03)
h_f = number of fishermen per household (1.82)

Based on these data, the calculated total was 1,116,508. However, it is recognized that this is a crude estimate and incorporates all the biases inherent in questionnaire data.

Respondents spent an average of $11 per trip-day. At this rate, the total annual expenditures by fishermen in the study area would have amounted to some $12,281,600 in 1977. Participants were also asked how much would be required to compensate them for the loss of a day's fishing. Replies averaged $36, which was lower than the national average of $59.80 per day reported by the Sport Fishing Institute (1977). Using these figures as extremes, the marine recreational fishery of eastern Long Island has an economic value of between $40,194,000 and $66,767,000 exclusive of anglers who do not reside there.

Licensing and Regulation

A saltwater sport fishing license was favored by 48.6 per cent of the respondents, provided the revenue would be used to enhance and manage fisheries. However, 20.8 per cent were undecided. Regulations fixing minimum size and limiting the daily catch have historically been controversial with saltwater anglers. In the present study, 81.6 per cent of the respondents indicated they favored such regulations, while 7.2 per cent were opposed to any agency having any jurisdiction over sport fisheries.

Commercial Fishing

The 42 respondents (5 per cent) who were commercial fishermen were too small a sample upon which to base conclusions. On the other hand, although not all of the respondents answered all the questions concerning commercial fishing, the data probably suggest the views held by the group as a whole. Strong support (23 of 24) was expressed for the establishment of zones exclusively for commercial fishing in areas having limited or declining fish stocks. A substantial proportion (28 of 40) said they had noticed no change in their catch as a result of the extension of the national jurisdiction over fishing in coastal waters to 200 miles. With respect to the establishment of a marine commercial fishing license, 4 of 22 indicated that they would oppose such legislation. On the other hand, 17 of 22 suggested they would support it if the revenue was used for reseeding shellfish beds. Only 1 of 22 were interested in the construction of additional commercial fishing piers and docks.

The respondents indicated they would support legislation to require that recreational shellfishermen in Nassau and Suffolk Counties be licensed. About half of those who commented on it were opposed to a general saltwater sport fishing license.

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GENERAL NOTES

A POSSIBLE DIFFERENCE IN HABITAT REQUIREMENTS BETWEEN THE NEW ENGLAND COTTONTAIL AND THE EASTERN COTTONTAIL

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In a study of cottontail rabbits and other small mammals on a small area in northeastern Connecticut, data were obtained that suggest a difference in habitat requirements between the New England cottontail (*Sylvilagus transitionalis*) and the eastern cottontail (*S. floridanus*). The study area was a tract of approximately 30 acres, known as Horsebarn Hill, on the University of Connecticut campus at Storrs, Connecticut. An aerial photograph taken in 1934 shows that most of the area was once open pasture. However, at the time of this study, it comprised old fields grown back to grass, brush and small trees, a red pine plantation, secondary hardwoods, and a strip of birch and aspen 10 to 12 feet in height running through the area underneath a powerline. Although the tract in general had a slope of 20 to 25 degrees leveling out onto a flat, its poor drainage created several small hardwood and alder swamps. Its soils and cover types had been previously described by Eabry (1968), and it is the opinion of the author that there had been no important change in the interim.

Eabry (1968) had trapped this area for irregular periods between October 1966 and April 1967 for a total of 1,014 trapnights, using 28 permanent trapsites established irregularly in the different cover types. Rabbits were live trapped and were tagged before being released. During this time he took 12 different eastern cottontails and 18 different New England cottontails (Table 1).

TABLE 1. RECORD OF COTTONTAIL RABBITS TRAPPED ON HORSEBARN HILL*, 1966-1970

Period	Trapnights	Number of individuals	
		Eastern cottontail	New England cottontail
October 1966 to April 1967	1,014	12	18
March and November 1968	unknown	9	0
September and November 1969	1,260	12	0
October and November 1970	1,204	15	0
October 1971 to March 1972	1,064	5	2

*Located on campus of University of Connecticut, Storrs, Conn.

The area was also trapped, although at only a few trapsites, between March and November in 1968 (W. G. Tabaeinsky, J. E. Johnston: unpublished fieldnotes). Trapping was done at all 28 permanent trapsites between September and November in 1969 (Morejohn, Bethothy, Stoddard: unpublished fieldnotes) and during October and November in 1970 (J. H. Marks: unpublished fieldnotes). During these years eastern cottontails were as numerous as before, but no New England cottontails were taken (Table 1).

The present study was carried on between October 1971 and March 1972. Trapping was done at irregular periods using all the 28 permanent trapsites previously established. One box trap (Pennsylvania Game Commission type R-4) was set at each site and visited daily. Rabbits caught were identified to species according to the pelage characteristics described by McDonough and Hames (1953). They were sexed and weighed, and their hindfoot measurements were noted. Those taken for the first time were marked with an aluminum tag and a colored washer (blue on the New England cottontail and red on the eastern cottontail) on one ear and tattooed on the other ear. Also, their tails were color coded, with picric acid (yellow) and rhodamine-B (purple) for the two species, respectively. All were released after being examined.

The traps were set for a total of 1,064 trapnights during which there were 20 captures of rabbits involving seven individuals of which two were New England cottontails (one male and one female) and five were eastern cottontails (two males and three females). The records for the New England cottontail were the first for this area since 1967 (Table 1).

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The distribution of the sites where the rabbits were taken suggests that the New England cottontail favored wet alder (*Alnus* spp.) areas and old fields at a succession stage of small trees. On the other hand, most of the eastern cottontails were captured in the fields that were open with low brush and grass cover as well as in the stand of 10- to 12-foot birch (*Betula papyrifera*) and aspen (*Populus tremuloides*) under the powerline. Of the eight captures of New England cottontails four (50 per cent) were in the alder areas, whereas the proportion was only one of 12 (8.3 per cent) for the other. Similarly, Eabry (1968) in 1966-67 took New England cottontails more frequently in the wet alder areas than in any other habitat type, and the proportion of captures there (20.7 per cent) was substantially greater than that (6.8 per cent) for the eastern cottontail.

During the years (1968-1970) when no New England cottontails were caught, trapping was done at all 28 trapsites in 1969 and 1970, and the eastern cottontail was taken generally throughout the area but favored the birch-aspen strip under the powerline. Between December 1967 and February 1968, this strip had been mechanically cleared, following which the new growth may have afforded a preferred food source for the eastern cottontail. On the other hand, most of the wet alder areas were under the powerline and the alders had been cut when it was cleared. The last New England cottontail reported by Eabry (1968) from Horsebarn Hill was taken in April 1967, and the species was not recorded again until October 1971 when the alders had regained their former height. The data suggest that this type of cover is an important element of suitable habitat for the New England cottontail and that, in this instance, the sudden disappearance of this species may have resulted from its removal. In another instance, Linkkila (1971) reported that on the Mansfield Hollow Dam area in Massachusetts both species were present in 1960 but that by 1967 the New England cottontail had disappeared. He noted that after about 1964 the minimum water level maintained by this dam permanently flooded fields along the river and may have destroyed cover types such as wet alder.

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AGE AND GROWTH OF ROCK BASS IN EASTERN LAKE ONTARIO[1]

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The rock bass (*Ambloplites rupestris*) occurs in all of the Great Lakes and is particularly abundant in Lake Ontario. Although not specifically sought by many anglers, it is often caught incidentally. The species supports a limited commercial fishery in Lake Ontario, and harvests have increased in recent years. In 1975, over 7,700 kilograms were landed, worth almost $25,000 to the fishermen (Great Lakes Fishery Laboratory, unpublished). However, published information on the natural history of rock bass is meager and limited largely to populations in small lakes and ponds.

Representing part of a study by the U.S. Fish and Wildlife Service to obtain basic biological data on the species in Lake Ontario, this paper describes the age and growth of rock bass collected in trapnets during May 1973 from Henderson Bay and Chaumont Bay in the eastern outlet basin. The fish populations in these areas are subjected to some of the heaviest sport fishing pressure in the lake. Information on age and growth is essential to the development of sound plans for managing the sport and commercial fisheries for this species in the nearshore waters of eastern Lake Ontario.

Materials and Methods

Rock bass were collected daily from May 16 to 23 in Henderson Bay and Chaumont Bay. These bays, approximately 11 kilometers apart, have similar fish populations and depth characteristics. Fish were captured in trapnets; the mesh size in the inner car-of each net varied from 3.2 to 3.8 centimeters (stretched mesh). All rock bass were removed from the nets each morning and taken to the laboratory where data were recorded for later analysis.

Total length, weight, sex and stage of maturity were noted, and scale samples were removed from an area immediately above the lateral line below the origin of the first dorsal fin. Scales were dried and impressions were made in cellulose acetate; all were read with the aid of a microprojector at a magnification of 42X. Scale measurements for calculating growth were made along the anterior-posterior axis of the anterior lobe of the scale. The edge of the scale was considered equivalent to an annulus because no new growth had occurred by mid-May.

Table 1. Length Frequencies, By Age Group, For Rock Bass From Henderson Bay and Chaumont Bay in Eastern Lake Ontario, May 1973

Length (millimeters)	Age group									Total
	III	IV	V	VI	VII	VIII	IX	X	XI	
110 - 119	1	..	..	..	..	..	..	..	..	1
120 - 129	1	..	..	..	..	..	..	..	..	1
130 - 139	2	2	..	..	..	..	..	..	..	4
140 - 149	1	10	..	..	..	..	..	..	..	11
150 - 159	1	38	4	..	..	..	..	..	..	43
160 - 169	..	74	14	2	..	..	..	..	..	90
170 - 179	..	72	43	18	1	..	..	..	..	134
180 - 189	..	52	65	48	32	4	..	..	..	201
190 - 199	..	17	33	67	73	7	3	..	..	200
200 - 209	..	3	19	61	95	28	4	..	..	210
210 - 219	..	1	8	33	70	37	2	..	..	151
220 - 229	..	1	1	18	39	34	16	3	..	112
230 - 239	..	..	..	2	21	14	15	3	4	59
240 - 249	..	..	..	..	8	17	8	8	2	43
250 - 259	..	..	..	..	6	3	6	3	1	19
260 - 269	..	..	..	..	..	1	2	1	..	4
270 - 279	..	..	..	..	..	1	..	4	..	5
Total	6	270	187	249	345	146	56	22	7	1,288
Percentage of total	0.5	21.0	14.5	19.3	26.8	11.3	4.4	1.7	0.5	100.0

[1]Contribution 539 of the Great Lakes Fishery Laboratory, U.S. Fish and Wildlife Service, Ann Arbor, Michigan 48105.

Regenerated scales were common. Of the 1,537 samples collected, 249 were discarded, leaving 1,288 specimens suitable for further analysis.

Rock bass taken in trapnets ranged in age from 3 to 11 years and in length from 111 to 276 millimeters (Table 1). Age VII fish were taken most frequently (26.8 per cent of the total catch) followed by age IV (21.0 per cent) and age VI (19.3 per cent). Considerable overlap in length occurred between age groups. One 10-millimeter length interval (220-229) contained fish of seven age groups, and four other length intervals included fish of six age groups. In age group VIII, the smallest fish was 99 millimeters shorter than the largest one.

The sex ratio of the fish collected was nearly 1:1, i.e., 48.4 per cent males and 51.6 per cent females. Most fish of both sexes were mature at age IV. Of the 1,288 specimens examined, only 12 were immature. The fish in age group III comprised three males (one immature) and three females (two immature). In age group IV, 123 of 130 males and all of 140 females were mature. Of the 105 males and 82 females in age group V, one fish of each sex was immature.

Body-Scale Relationship and Calculated Growth in Length

The body-scale relationship for rock bass in Lake Ontario was derived from fish grouped in 5-millimeter length intervals. Regressions were calculated separately for males and females; however, the slopes and intercepts were so close empirically that the data were pooled and the following linear regression was calculated

$$L = 79.30 + 0.80\,(S)$$

where:

L = total length in millimeters
S = scale radius in millimeters (X42)

Hile (1941) described the body-scale relationship of rock bass in Nebish Lake (Wisconsin) as curvilinear. His curvilinear expression probably more closely defined the Nebish Lake population because he included small fish (shorter than 20 millimeters) in his computations. The smallest fish used in the present computation was 137 millimeters long.

Calculated total lengths at the end of each year of life for the different age groups among the fish collected in Lake Ontario are presented in Table 2. Mean lengths for each year were calculated by averaging the mean lengths for the several age groups included, weighted by the number of fish in each group. Lee's phenomenon of apparent decrease in growth rate with increase in age is evident. Growth was similar during the first two years of life, increased slightly during the third year, decreased markedly during the fourth year, and decreased slightly each subsequent year.

TABLE 2. CALCULATED TOTAL LENGTHS BY AGE GROUP, AND WEIGHTS, AT THE END OF EACH YEAR OF LIFE FOR ROCK BASS (SEXES COMBINED) FROM EASTERN LAKE ONTARIO, MAY 1973

Age group	Number	Year of life										
		1	2	3	4	5	6	7	8	9	10	11
		Length (millimeters)										
III	6	51	93	150	..	..	..	..	..	..	..	..
IV	270	47	104	158	179	..	..	..	..	..	..	..
V	187	48	96	153	176	191	..	..	..	..	..	..
VI	249	47	86	143	167	186	197	..	..	..	..	..
VII	345	48	86	141	164	184	197	205	..	..	..	..
VIII	146	47	85	142	163	182	195	207	214	..	..	..
IX	56	42	85	142	163	180	193	203	212	218	..	..
X	22	42	75	136	157	175	188	200	211	219	226	..
XI	7	45	80	135	154	169	184	198	208	217	223	227
Weighted mean		47	91	147	169	185	196	205	213	218	225	227
Annual increment		47	44	56	22	16	11	9	8	5	7	2
		Weight (grams)										
Calculated weight		12	15	66	101	134	160	183	206	222	244	251
Annual increment		12	3	51	35	33	26	23	23	16	22	7

Length-weight relationship and calculated growth in weight

Separate calculations of the length-weight relationship for males and females indicated no significant difference in the slopes and intercepts; therefore, the data were combined and the following geometric mean functional length-weight regression was calculated

$$\log W = -4.88 + 3.09 \log L$$

where:

W = weight in grams
L = total length in millimeters

The regression compares very closely with that derived by Hile (1941) for rock bass in Nebish Lake ($\log W = -4.54 + 3.00 \log L$).

Weights of fish at the end of each year of life, calculated by applying the weighted mean lengths to the length-weight equation, are also given in Table 2. Increments in weight were greatest during the third year and gradually decreased each succeeding year.

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SNORKELING AS A MEANS OF EVALUATING FISH POPULATIONS IN STREAMS[1]

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Relative abundance of fishes and species composition in a body of water are of interest not only to ichthyologists but to anyone concerned with the aquatic environment. Much of our knowledge of fish populations in streams was obtained by biologists making fish surveys, usually by seining. Since it is expensive to both quantify and qualify such populations in this way, few studies did both and fewer still did both over appreciable periods of time. Nevertheless, information of this sort in terms of both space and time is important, and snorkeling is a technique that, under suitable conditions, can accomplish this faster and cheaper than any other method. Since the summer of 1974 the authors have used it to evaluate approximately 200 kilometers of streams in Connecticut, 30 kilometers in Tennessee and 6 kilometers in Rhode Island. This paper discusses the advantages and disadvantages of this method.

Snorkel surveys are made by having from one to four observers (depending on stream width) in wetsuits either float downstream with the current or swim at intermediate speeds (not more than 1.5 kilometers per hour) through sections of a stream and count the number of individuals of each species, or taxon, seen. In the streams surveyed by the authors, sections

A snorkeler. Note plastic recording band on right arm and position of arms to protect head.

varied from 0.5 to 11.0 kilometers in length. Young of the year and unidentifiable specimens are not counted. Population densities are the sum of the numbers counted by all observers and are expressed as the number of individuals of each taxon seen per kilometer of stream. An occurrence rating is then assigned to each species based on the number per kilometer (less than 1 = 1, 1-10 = 2, 11-50 = 3, 51-100 = 4, 101-500 = 5, 501-1,000 = 6 and more than 1,000 = 7). These ratings are used to make comparisons between and within streams, water-

[1]Scientific Contribution No. 719 of the Storrs Agricultural Experiment Station of the University of Connecticut. Surveys in Tennessee were made possible by a grant from the University of Connecticut Research Foundation.

Table 1. Relative Abundance of Fish Species As Indicated by Occurrence Ratings Based on Snorkeling Observations For Certain Streams in Connecticut*

Stream and watershed	Size of watershed (square kilometers)	Distance covered§ (kilometers)	Occurrence rating						
			1	2	3	4	5	6	7
Shepaug River Housatonic	403	11.0	ST	LA LM LG	NC	RC EO	MD RA	SC SA	CC NX
Salmon River Connecticut	387	5.6	MS	AR LG PF LA EO	MD RA	AP?	CC NX		SC
Yantic Thames	254	9.5	LM IN SF RC IC SG	MS RA PF LG EN ST		MD	LA NC	CC NX	SC

*Derived from data collected in summer of 1974.
§Total distance if snorkeled more than once.
Abbreviations:

AP = *Alosa pseudoharengus*
AR = *Anguilla rostrata*
CC = *Catostomus commersoni*
EN = *Esox niger*
EO = *Etheostoma olmstedi*
IC = *Ictalurus catus*
IN = *Ictalurus nebulosus*
LA = *Lepomis auritus*
LG = *Lepomis gibbosus*
LM = *Lepomis macrochirus*
MD = *Micropterus dolomieui*
MS = *Micropterus salmoides*
NC = *Notemigonus crysoleucas*
NX = *Notropis cornutus*
PF = *Perca flavescens*
RA = *Rhinichthys atratulus*
RC = *Rhinichthys cataractae*
SA = *Semotilus atromaculatus*
SC = *Semotilus corporalis*
SF = *Salvelinus fontinalis*
SG = *Salmo gairdneri*
ST = *Salmo trutta*

sheds and taxons (Table 1). Also, they may be summed for each species, divided by the number of streams in which the species was seen and used as an index of species abundance.

Although snorkeling requires additional training to identify fish under water, all methods of quantifying and qualifying fish in streams demand that the samplers be skilled in fish taxonomy. It is felt that the additional time required for snorkeling is minimal. For example, in a single survey of a stream with a diverse fauna, the Conasauga River in Tennessee, two snorkelers with some prior fish-collecting but no snorkeling experience in that area saw about three-quarters of the number of species reported by Stiles and Etnier (1971), saw about twice the number their colleagues collected by seining (Table 2) and saw one gar, a species that Stiles and Etnier did not report. The authors feel that after using the snorkeling method only a short time in this river they would have identified most of the species present.

In the Connecticut River, it was possible to identify all adult fish except for the alewife and blueback herring. The results of snorkel surveys of the fish fauna in this stream were not only similar to those of a previous seine survey (Whitworth et al., 1968) in qualifying the fauna but also provided good quantitative evaluations (Table 3). The number of rare species reported exclusively by each method was similar (five by snorkeling and four by seining) and was undoubtedly more a function of time than of differences in the techniques.

TABLE 2. COMPARATIVE NUMBERS OF FAMILIES RECORDED BY SNORKELING AND SEINING IN THE CONASAYGA RIVER IN TENNESSEE AND NUMBER PREVIOUSLY RECORDED

Family	Snorkling*		Seining	Previously recorded§
	Observer 1	Observer 2		
Catostomidae	3 (2)	3 (3)	2	6
Centrarchidae	3 (3)	3 (3)	1	9
Cottidae	0	0	1	1
Cyprinidae	11 (7)	13 (7)	9	14
Ictaluridae	0	1 (1)	1	4
Lepisosteidae	0	1	0	0
Percidae	16 (4)	14 (2)	5	14
Total	33 (16)	35 (16)	19	48

*Figures in parentheses represent number identified to species.
§According to Stiles and Etnier (1971).

TABLE 3. COMPARATIVE EVALUATION OF THE FISH POPULATION IN SALMON BROOK (IN THE CONNECTICUT RIVER DRAINAGE) BY SNORKELING AND SEINING

Species	Relative occurrence	
	Snorkeling*	Seining§
Anguilla rostrata	1	. .
Catostomus commersoni	5	3
Cottus cognatus	1	1
Esox americanus	. .	1
Etheostoma olmstedi	4	3
Fundulus diaphanus	. .	1
Lepomis gibbosus	1	. .
Micropterus salmoides	1	. .
Notemigonus crysoleucus	. .	1
Notropis cornutus	6	3
Notropis bifrenatus	. .	1
Perca flavescens	1	1
Rhinichthys atratalus	6	3
Rhinichthys cataractae	2	2
Salmo trutta	2	1
Salvelinus fontinalis	2	. .
Semotilus corporalis	3	2

*Occurrence rating (see text).
§Of three locations, number at which found.

Snorkeling makes one more sensitive to variations in occurrence within species and increases the possibility of discovering a new species (*Percina tanasi* (Etnier, 1976) was discovered while snorkeling) because more individuals in a watercourse are seen and their habits and habitats observed. Similarly, differences in life history between and within species in a watercourse are better defined. Once differences are noted, individuals can be easily collected by other techniques because their distribution and abundance are known, and effort can be expended in the most productive areas.

Another major advantage of snorkeling is the low number of man-hours required to evaluate a stream and obtain a comparative index. Two men can evaluate some 1.5 to 3.0 kilometers of stream per hour and in 15 minutes or less calculate occurrence indicies. Chemical, electrical and mechanical sampling techniques all require more time in the field.

The major disadvantage of snorkeling is that the observer should have at least 2 meters horizontal visibility and the watercourse should average at least 15 centimeters deep. This is usually no problem if the surveys can be performed at convenience rather than on a strict schedule. As with all sampling techniques, except chemical, some species are not evaluated properly. The authors have had poor success in seeing madtoms and sculpins, and the numbers of eels and lampreys seen are not indicative of the real numbers present. On the other hand, for trout, suckers, minnows, sunfishes and darters the number seen while snorkeling is usually a reliable index.

The authors feel that, in streams suitable for its use, snorkeling is an excellent method of quantifying and qualifying fish populations in streams through space and time, and of evaluating variations within and between species and watersheds. It also facilitates the recognition of rare, or even new, species.

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MOVEMENT OF AN EASTERN COYOTE FROM VERMONT TO NEW YORK

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Movement of mammals has been documented by marking, tagging and radio telemetry. Such records include movements of 60 miles for black bears (*Ursus americanus*) in the Adirondacks (Sauer et al., 1969), 130 miles for red foxes (*Vulpes fulva*) in the Midwest (Storm et al., 1976) and 53 miles for red foxes in central and western New York (B. F. Tullar, personal communication, 1978), and 85 miles for timber wolves (*Canis lupus*) in Algonquin Provincial Park (Pimlott et al., 1969).

Several studies have reported the movement of juvenile coyotes (*Canis latrans*). Coyotes, ear tagged as pups in New Mexico and Wyoming, were recovered at average distances of between 20 and 31 miles from their point of capture (Robinson and Cummings, 1951; Young and Jackson, 1951). Juveniles, ear tagged in California, moved an average of 3 to 4 miles (Hawthorne, 1972). In Alberta, ear-tagged females moved an average of 19.7 miles (Nellis and Keith, 1976). In Minnesota, radio-collared coyotes travelled an average of 30 miles from their point of capture (Berg and Chesness, 1978). Distances greater than 100 miles have been recorded for both eastern and western coyotes (Chambers et al., 1974; Robinson and Cummings, 1951; Young and Jackson, 1951).

The present note documents the movement of a juvenile eastern coyote (*Canis latrans* var.). On October 18, 1976 a 20-pound female coyote pup was live trapped, ear tagged, radio collared and released by the junior author 3 miles northwest of Johnson, Vermont. Through radio telemetry, 32 fixed positions for this animal were determined from then until March 8, 1977. For the first six weeks, it remained within 1 mile south and west of the point of release. In late November the signal was lost for a week, and, when relocated, the coyote was found 6 miles to the northwest. In early December the signal was lost again, and when relocated it was 6 miles farther west. The signal was last located 4 miles north of Fairfax (Vt.) and 15 miles (in a straight line) from the point of release. Adding the distances between the successive known locations indicates this animal travelled a minimum of 38 miles to arrive at the final point of radio contact.

On January 24, 1978 a hunter killed this marked coyote in New York 2 1/2 miles south of Ellenburg Center in Clinton County. It is presumed that it had crossed frozen Lake Champlain shortly after March 8, 1977 and continued wandering in a westerly direction into New York. The straight-line distance from its last known location in Vermont was 44 miles, and that from the original point of release was 59 miles.

The animal was necropsied six days after it was killed. The whole weight was 27 pounds, a gain of only 7 pounds during the 15 months following its capture and release. Its stomach contents included the hair of a snowshoe hare (*Lepus americanus*) and hair and hoof material from a calf. (The hunter reported that a dead calf was found very close to where the coyote was killed, but it is believed not to have been killed by coyotes.) Examination of the reproductive tract indicated that the animal had never ovulated.

This specimen had been marked by the junior author in connection with graduate studies at the University of Massachusetts. When it came to the attention of the senior author in New York, some difficulty was experienced in learning who had tagged it. It is suggested that those engaged in radio telemetry studies identify themselves or their institution not only on the ear tag but also on the radio collar.

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POLYCHLORINATED BIPHENYLS IN MOSSES IN THE ADIRONDACK REGION OF NEW YORK

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Mosses may serve as indicators of the extent of air pollution since they derive their nutrients largely from the air and apparently absorb or adsorb foreign constituents in the process. Mosses have been analyzed and reported to be indicative of the magnitude of air pollution by fluorine (Mac Intire et al., 1952), lead (Skaar et al., 1973; Martinez et al., 1971; Robinson et al., 1973; Hirao and Patterson, 1974; Ruhling and Tyler, 1968), mercury (Yeaple, 1972; Huckabee, 1973) and zinc (Nash, 1975). The accumulation of elements from specific sources has also been reported by others (Ruhling and Tyler, 1969, 1970, 1971; Burkitt et al., 1972; Shacklette and Conner, 1973; Tomassini et al., 1976; Nash, 1976; Furr et al., 1979).

It was recently reported that polychlorinated biphenyls (PCB's) were found in precipitation in the Lake Michigan basin (Murphy and Rzeszutko, 1978). Winds moving largely in a northeasterly direction are believed to transport pollutants from distant urban, industrial and other areas into the Northeast whereupon substantial amounts are deposited, by rain or settling out, in the mountainous Adirondack region of northern New York. In the work reported here, *Sphagnum* mosses were collected in the Adirondacks and analyzed for PCB's. A moss sample was also collected near the industrial Ruhr region of West Germany and similarly analyzed.

The location of the collection sites is given in Table 1. The mosses were sampled in open bogs above many layers of previously humified mosses. They appeared healthy and normal in color and growth characteristics. Sampling within 0.4 kilometer of roads was avoided to

Table 1. Locations Where Moss Samples Were Collected

Sample No.	Location
1 - 7	Bisby Lake region about 16 kilometers southeast of Old Forge in the southwestern Adirondacks
8 - 10	Vicinity of Paul Smiths about 40 kilometers south of Malone in the northern Adirondacks
11	0.4 kilometer west of Forestmere Lake about 40 kilometers south of Malone in the northern Adirondacks
12	Idstedt in West Germany, between Fleusberg and Schleswig

minimize possible contamination that might have resulted from nearby traffic. For each sample, about 4 kilograms (fresh weight) of moss, i.e., about 5 centimeters in thickness, was collected. After removing adhering substrate and litter, the mosses were freeze dried, milled to a fine consistency, thoroughly mixed and subsampled prior to analysis. PCB's were determined as Aroclor 1254 by electron capture gas chromatography following extraction by blending with water and acetonitrile, partitioning into hexane and isolation on a Florisil column (Anonymous, 1971).

The concentrations of PCB's found in the moss samples are listed in Table 2. Whereas the samples from New York contained appreciable levels of PCB's, the highest (No. 7) contained only about half as much as the single sample from the Ruhr region (No. 12).

PCB's are widely used as insulating fluids in transformers and heat exchangers, as plasticizers, as dye carriers in printing inks and in many other applications. They have therefore become ubiquitous in the environment. It is possible that such PCB compounds associated with particulate material or as vapors are carried long distances from their source by wind currents, but the aerodynamics of such processes are little understood. Without further analysis one can only speculate on the possible extent of contamination of the flora and fauna in such regions of atmospheric fallout as the Adirondacks. Mosses *per se* are not known

Table 2. Concentrations of PCB's in Moss Samples From the Adirondack Region of New York and the Ruhr Region of West Germany

Sample	PCB* (ppb, dry weight)
Adirondack region	
1	178
2	224
3	237
4	174
5	155
6	272
7	659
8	161
9	472
10	158
11	148
Ruhr region	
12	1,339

*As Aroclor 1254.

to serve as an important source of food for any wildlife species found there. Soils and lakes in the Adirondack region are undoubtedly also contaminated by PCB's through rainout and particulate settling. It has been reported that PCB's are taken up by plants growing on soils containing them (Lawrence and Tosine, 1977; Iwata et al., 1974). Fish may also contain PCB's (Bache et al., 1972) presumably accumulated from water and associated aquatic food materials containing the compounds.

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MARINE FISHES OF SOUTHERN ORIGIN IN NEW YORK WATERS AND THEIR CONTRIBUTION TO THE FISHERY[1]

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The marine ichthyofauna of the southeastern tip of Long Island (N.Y.) comprises species of the middle Atlantic region, northern New England and Canada, as well as representatives of subtropical areas. Nichols (1919) recognized this dichotomy and stated that "New York lies in an intermediate latitude and its fauna is composed of northern and southern elements, rather equally mingled . . ." The occurrence of species of southern origin has been noted frequently over the years (as "rare" or "uncommon" or as "wanderers" or "stragglers"), including recent accounts by Alperin and Schaefer (1964, 1965), Alperin (1967), Briggs (1970) and Hickey et al. (1975). Little has been published, however, on their contribution to the fishery in New York waters, although some are more common than reports indicate and often add to the summer catch of local commercial fishermen.

Fort Pond Bay is situated at the eastern end of Long Island north of Montauk. It is south of Block Island Sound and southeast across Gardiner's Bay from Orient Point. The second author has operated two pound nets in the bay that have been used in studying the occurrence of species uncommon in this area (Hickey and Lester, 1975; Hickey et al., 1975, 1976). Throughout the 5-year period from June 1970 to November 1974 the contribution of species of southern origin to the marketed catch of fish from these nets was examined. The catch figures reported here represent only fish shipped to market and not the entire catch of these species; most of those caught were too small to be marketed and were therefore released unharmed. When fish of sufficient size or quantity were captured, they were sent to market only when the current price made it profitable to the fisherman. When the price was too low, marketable fish may have been released. The data are given as percentage by weight, actual poundage being confidential.

The pound-net fishing season in Fort Pond Bay begins in April or May and runs through October or early November. Prior to April and after November fish are scarce and the weather inclement. Marketable-sized fish of the southern species were never captured during April and May, and were taken only in small quantities during June and July. Most of them were captured and marketed during August, September and October (Table 1, Figure 1). During the 5-year period of study, southern species comprised 0.78 per cent by weight of the total marketed catch, but for the months of June to November when all of those marketed were taken their contribution was 1.02 per cent. The best harvest of southern species was made in 1973 when those marketed represented 48.9 per cent of the total poundage of such species marketed during the study.

Table 1. Contribution of Southern Species to the Total Marketed Catch From Two Pound Nets in Fort Pond Bay, By Month For the Period From June 1970 to November 1974

Month	Contribution* (percent by weight)
April	0.00
May	0.00
June	0.08
July	0.27
August	2.00
September	3.01
October	1.06
November	0.14

*Mean for each month during period of study.

[1]Contribution No. 57 of the New York Ocean Science Laboratory, based on a paper presented at the 1975 Northeast Fish and Wildlife Conference. The authors wish to acknowledge Dr. Herbert M. Austin and Dr. J. L. McHugh for reviewing the manuscript; David Gould for graphics, Dr. Rudolph Hollman and Stephan K. Gill for use of their water temperature data from Fort Pond Bay.

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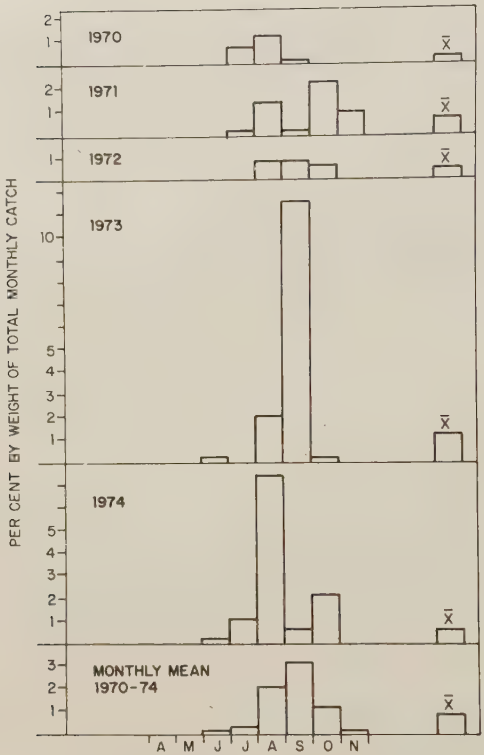

Figure 1. Monthly contribution (in percent by weight) of southern species to the total pound-net harvest of fish in Fort Pond Bay for the 5-year period from June 1970 to November 1974. Mean ($\bar{x}$) represents contribution of such species to the total harvest each year.

Surface water temperatures for Fort Pond Bay were recorded during 1973 and 1974, and these were compared with data compiled by the U.S. Coast and Geodetic Survey for the 8-year period 1947-1954 (Table 2). Monthly mean temperatures did not vary greatly between the years included. However, from August 28 to September 8 in 1973 the Bay was extremely warm as temperatures ranged from 70° to 77° F. (mean daily temperature, 73.1° F.). During this period and through September 28 (mean, 65° F.) the harvest of southern fishes was exceptionally good.

The marketed southern fish were all from three families (Table 3), although many others were represented in the total catch (Hickey et al., 1975). The little tunny (false albacore) and blue runner comprised 81.9 per cent of the total by weight, and in September 1973 accounted for 11.5 per cent of the total harvest of all species, the largest monthly contribution by southern species to this fishery during the 5-year period. Blue runners ranged up to 5 pounds, market size generally being about 2.5 to 3 pounds and more than 250 millimeters in standard length. Spanish mackerel ranged in size from about 2 to 19 pounds, while snappers were all 31 to 32 pounds. The market for most of the catch reported in the present study was the Fulton

TABLE 2. MONTHLY SURFACE WATER TEMPERATURES IN FORT POND BAY DURING POUND NET FISHING SEASON IN 1973 AND 1974 COMPARED WITH THOSE FOR THE PERIOD 1947-1954

	Temperature (degrees Fahrenheit)					
	1973*		1974*		1947-1954§	
Month	Mean	Range	Mean	Range	Mean	Range
April	43.4	40.7-52.0	46.5	42.0-50.1	45.1	39-52
May	52.7	48.0-59.0	53.0	48.5-57.0	52.2	44-59
June	61.6	57.0-68.0	60.9	55.0-66.5	61.8	52-72
July	68.5	64.5-75.5	69.4	65.5-71.5	68.9	63-76
August	70.6	66.5-75.4	71.8	70.0-74.2	70.3	65-76
September	67.8	61.5-77.0	68.4	65.0-71.5	67.7	61-74
October	61.1	56.5-65.5	59.1	54.2-65.5	61.6	53-67
November	50.2	47.0-56.5	53.1	46.0-57.5	52.8	43-60

*Data courtesy of Dr. Rudolph Hollman and Stephan K. Gill of the New York Ocean Science Laboratory.
§From U.S. Coast and Geodetic Survey (1955, p. 13).

TABLE 3. SPECIES COMPOSITION OF THE TOTAL MARKETED CATCH OF SOUTHERN FISHES FROM TWO POUND NETS IN FORT POND BAY FROM JUNE 1970 TO NOVEMBER 1974

Family and species	Proportion of catch (per cent by weight)
Scombridae	
Little tunny (*Euthynnus alletteratus*)	54.5
Atlantic bonito (*Sarda sarda*)	7.2
Spanish mackerel (*Scomberomorus maculatus*)	5.4
Cero (*Scomberomorus regalis*)	1.3
Carangidae	
Blue runner (*Caranx crysos*)	27.4
Lutjanidae	
Snapper (*Lutjanus* sp.)	4.2
Total	100.0

Fish Market in New York City. Some species, notably Spanish mackerel and bonito were sold at local fish markets during the summer tourist season.

McHugh (1960) studied the pound net fishery of Virginia and found that the blue runner was also taken there and never earlier than mid-August. It was used mostly for scrap or bait rather than human consumption. Bigelow and Schroeder (1953) reported that blue runners were not rare in the Cape Cod region, but that specimens captured by pound net were usually small (150-200 millimeters). They noted that little tunny, bonito, cero and Spanish mackerel were also taken in Cape Cod waters. Alperin (1967) found that recreational fishermen on Long Island frequently caught blue runners and also used them for bait.

Using data from the "fish books" of a Maryland haul-seine fisherman, Massman (1961) described a Potomac River shad fishery that existed during the period 1814-1824 and made comprehensive comparisons with data recorded more than 100 years later. He stated that he hoped his effort would "stimulate others in the search for and publication of old records that may add perspective to studies of fisheries at the present time". Similarly, Royce (1972) stated that "Many commercial fishermen keep personal records of their catches and fishing activities either in a vessel log or a business log. These may provide invaluable information to the fishery scientist on location and amount of catches by area." The information presented here for one location on eastern Long Island is a result of the combined skills of fisherman and scientist and should provide additional insight into one of the richest and most diversified fishing areas of the U.S. Atlantic seaboard.

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AN EARLY-BORN FAWN IN NEW YORK

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On February 17, 1979, a wild female white-tailed deer (*Odocoileous virginianus*) was observed giving birth to a fawn. The incident occurred in the village of Locke in Cayuga County (N.Y.) on the property of Rocky Figgolari who witnessed it. The doe and fawn were observed later the same day by the junior author who informed the Department's regional office in Cortland.

Although there have been many reports of both early- and late-born fawns, this incident would appear to be unique in two respects. First, it is the earliest confirmed report of the birth of a wild fawn in New York. Second, the temperature on February 17 at 8:30 a.m., when the fawn was born, was -29° C. (-20° F.). During the next two days, the low temperature in the vicinity was -30° C. (-22° F.), and the high was -13° C. (9° F.). Moderating temperatures from February 20 to 24 reached a high of 4° C. (40° F.). About two days after its birth, Mr. Figgolari approached the fawn, picked it up and noted that it was a male. The doe and fawn, which were subsequently observed several times, were last seen on February 28 by Mr. Figgolari and at that time the fawn seemed to be doing very well.

The peak of breeding among deer in New York occurs in mid-November, and the peak of fawning in early June. The earliest breeding date recorded by Cheatum and Morton (1946) was September 22-28 and the latest February 16-22. Jackson and Hesselton (1973), from a sample of 894 females, determined that the breeding season ranged from October 1 to February 9 with the peak in mid-November. Parturition dates estimated from embryo development ranged from April 30 to August 30. Assuming a gestation period of 202 days, the doe reported here was bred on approximately July 22.

The junior author observed that this doe was very small and appeared to be only a yearling itself. It was one of about a dozen wild deer that were frequenting the area behind Mr. Figgolari's home. They were coming to corn and apples provided by him and a local sportsmen's club. Snow depths in February in the Locke area ranged from 6 to 18 inches with good supporting crusts that enabled the deer to forage at will for food in the mixed farm-woodland habitat.

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Errata

In the July 1978 issue (Vol. 25, No. 2), in the caption of the illustration on page 180, the letter designations are reversed, i.e., in the photo "A" is the alimentary canal of a red-tailed hawk and "B" that of an osprey.

The *New York Fish and Game Journal* is devoted to presenting the results of research and management studies in New York, and other technical papers on related subjects, that pertain to fish and wildlife problems of concern to the Department of Environmental Conservation. It is published semi-annually and is distributed free to official conservation agencies and scientific institutions. It is also furnished free to selected libraries and conservation organizations in New York State. Others may subscribe at a rate of $1.50 per year or obtain individual issues for 75¢ per copy. Correspondence should be addressed to the Editor Robert W. Darrow, New York State Department of Environmental Conservation, Wildlife Resources Center, Delmar, N.Y. 12054.

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